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PAPERS TO BE PRESENTED
BEFORE THE SECTION ON

# OPHTHALMOLOGY

OF THE

AMERICAN MEDICAL ASSOCIATION

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Boston, June 5-8, 1906

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# TO THE MEMBERS OF THE SECTION ON OPHTHALMOLOGY OF THE AMERICAN MEDICAL ASSOCIATION.

In presenting to the members of the Section on Ophthalmology of the American Medical Association printed copies of the papers accepted for the Section program for the session that is to be held in Boston, June 5-8, 1906, the officers and executive committee are carrying out a plan which, though attended with increased labor and expense, is considered by them to be a progressive feature which will be appreciated by the members of the Section, and which will probably be found worthy of further trial at future sessions. As stated in the circular sent to members several months ago, it is the intention to do away with the formal reading of papers at the Boston session, though each essayist will be given an opportunity of introducing as well as of closing the discussion of his paper. Members are, therefore, respectfully asked to read the papers carefully before going to Boston, with a view not only of becoming familiar with the substance of the papers, but also for the purpose of preparation to take part in a more intelligent and comprehensive discussion which such a plan is certain to bring out.

The officers desire to express their appreciation of the co-operation of the essayists in carrying the plan to its present stage, and earnestly request the co-operation of all of the members of the Section in an endeavor to give this scheme the best possible opportunity of proving whether it is worthy of adoption for future sessions.

Albert E. Bulson, Jr., Secretary.

Lewis H. Taylor, Chairman.

# DR. HOWE'S RESOLUTION ON TEST METHODS.

*To the Members of the Section:*

With the hope of lessening some of the confusion at present existing in the method of measuring the strength of the extraocular muscles, Dr. Lucien Howe, of Buffalo, offers the resolutions given below, which he desires adopted by the Section on Ophthalmology at the Boston session. With a view to giving the members an opportunity of giving the subject careful thought as a basis of intelligent action at Boston, the resolutions are sent out in advance of the session at the request of Dr. Howe.

ALBERT E. BULSON, JR., Secretary.

**WHEREAS, It is a well established fact that when making tests of the strength of the extraocular muscles, if the examiner selects different prisms from the test case, or when using prisms in series, or revolving prisms, if he begins with those which the patient *can not* overcome, and gradually *decreases* their strength to a prism which the patient can overcome, then one set of results is obtained. But on the other hand, when using prisms in series or revolving prisms, if the examiner begins with those which the patient *can* overcome, and gradually *increases* the strength of the prisms, then the one found necessary to produce diplopia is decidedly stronger than by the former method; and,**

**WHEREAS, When the former method is adopted the results are much more constant and exact than by the latter method; and,**

**WHEREAS, No matter in what way the measurements have been made, when the result is recorded in the strength of the prism, which can be overcome, some practitioners count that as if a prism were held before each eye, and others as if one prism of twice the strength were held before one eye only; and,**

**WHEREAS, These differences in methods of using prisms and of recording the results of tests, have given rise to different estimates of the strength of the extraocular muscles, with corresponding confusion of our ideas on the subject; and,**

**WHEREAS, One of the prime objects of a national medical association is to make our methods and records more uniform, and, therefore, more intelligible to ourselves and to each other; therefore, be it**

*Resolved,* That it is the sense of the Section on Ophthalmology of the American Medical Association, that hereafter, when any member describes the strength of the extraocular muscles, it is to be understood, unless specified to the contrary, that in making these measurements the examiner has used prisms selected from the ordinary test case, or if he did use prisms in series or revolving prisms, in doing so he commenced the measurement with prisms which were sufficiently strong to produce a well marked diplopia, and then *decreased* the strength of the prisms until one was found which could be overcome by the patient; and,

*Resolved,* That in recording the strength of the prism which can be overcome by any such tests, it is to be understood, unless specified to the contrary, that the number given is to express the total fusion power, that is, the strength of the one prism which is required to produce the result, and not half the fusion power, as when a prism of half that strength is held before each eye.

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# A MORE UNIFORM STANDARD FOR THE ILLUMINATION OF VISUAL TEST-TYPES.*

CHARLES H. WILLIAMS, M.D.
BOSTON.

At our last session in Portland, Oregon, the illumination of some test-types which I showed was criticized, and justly so, on account of being too intense. If the light reflected from the test-type card is too bright the retina soon becomes fatigued, there is more irradiation, and the results obtained are less reliable than where a weaker illumination is used; on the other hand, if the light is too weak, we do not get a proper measure of the acuteness of vision under the conditions of ordinary use. We need some standard which will come between these two extremes, which will be constant, so that the acuteness of vision of any individual to-day can be properly compared with his record of any previous time, and which will allow the reported records of one examiner to be compared with those of another.

It is easy to measure with great accuracy small differences in heat, or in the amount of an electric current, but with light these measurements can not be made with anything like the same accuracy, and for the purpose of measuring the amount of light reflected from a card of test-types, and of noting the point where the light reflected from the card becomes so much reduced in comparison to that reflected from the surface of the letters that the letters can no longer be read, it has been necessary to devise two special forms of photometer, which will be explained later.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

## STANDARD ILLUMINATION.

For practical purposes it will be best to state first the conclusions which have been reached after many trials and then to describe some of the tests. The most satisfactory results have been obtained by hanging the card of test-types in a cabinet painted a dull black, the opening being three feet wide by four feet high. On each side of this rectangular opening, right and left, is arranged a vertical column of small incandescent lamps of 5 candle power each, eight on each side, made to burn four in series on a current of 110 volts. These lamps are arranged at equal intervals, the highest and lowest being as near the top and bottom of the cabinet as possible, and are so placed that the lamps of one side come opposite the intervals between the lamps of the opposite side, thus making a more even distribution of the light. This vertical column of eight lamps on each side is protected by a blackened tin screen so that no light will pass direct from them to the observer, but so that the full amount of light will be thrown on the test card. The lights are one foot in front of the plane of the test-types, and about fourteen inches from the nearest edge of the card, and "frosted" bulbs are used.

With the lights arranged in this way, an even and constant illumination will be obtained over the whole surface of the card, the light will not be too intense, especially if the test-types are printed on paper of a light brownish tint, or, which is the same thing, if the paper has become darkened with age.

The above arrangement supposes that the office is supplied with an electric current, which is almost a necessity at the present day, but in many cases this is not available, and we need some measure of the amount of light reflected from a series of test-types at the ordinary distance of five meters, and some means of comparing this light with the amount reflected from such a standard as above described.

## THE SIMPLEX PHOTOMETER.

A "simplex" photometer, which I devised last summer for measuring the relative brightness of signal lights at a distance of half a mile or more, seems to answer also for the comparison of the light reflected from different test cards, or from the same card under varying illumination.

This photometer consists of two developed glass negatives cut in strips about six inches long by three-quarters of an inch wide, placed face to face and mounted in a metal case. The film on each negative increases in density in a geometrical ratio from the clear end toward the dense end. These negatives are made at the Observatory of Harvard College with the same apparatus which is used for making photometric films for astronomical work and they give a very even and regular gradation.

To measure the brightness of a light, the photometer is held in front of the eye so that the light to be measured is seen through the clear end of the photometer film, the glass is then slowly moved so as to bring the denser portions of the film in line with the light until a point is found where the light is just extinguished by the absorption of the film. The amount of light cut off by the film at this point measures the intensity of the light tested, and can be read off on a scale attached to the glass photometric negative. It has been found most convenient to mount the negative in a metal case shaped like a razor case, a sighting hole is punched in both sides of the case through which the light to be tested is observed, and directly below this is another hole in one side of the case through which the scale of the instrument can be read (Fig. 2).

**Figure 1 shows the instrument closed, as it is carried in the pocket.**

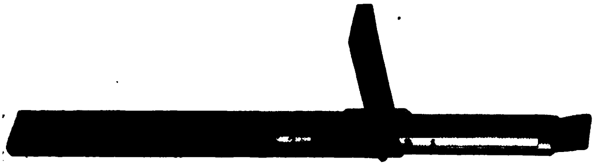

**Figure 2 shows the instrument open ready for use. The cap is removed, the wire at the end of the cap is slipped over the end of the instrument to make a shield for the observer's eye.**

Figure 3 shows the position in which the photometer is held when in use, resting firmly on the nose with the hole in the case before the eye.

The accurate marking of the scale on these instruments was rather difficult. The developed negatives giving a gradually increasing density of film were made with the greatest care, so far as selection of plates, time of exposure, developer, etc., were concerned; yet with the greatest attention to details the films could not all come out alike, and, although there was very little trouble as to the gradually increasing density of the film, yet some films would be denser throughout than others, and a certain point, say at 10 cm. from the clear end of the film, would not, in all cases, cut off the same amount of light. In order to have a uniform scale for all the instruments, it was found necessary to have a series of standard shade glasses prepared. Each photometer was then compared with this set of glasses, and the scale of each instrument was marked from the result of this comparison. These standard shade glasses were made under the direction of Mr. E. S. King, of the Observatory staff, who has been very helpful throughout these investigations, and a series of standard shade glasses was finally obtained which did not

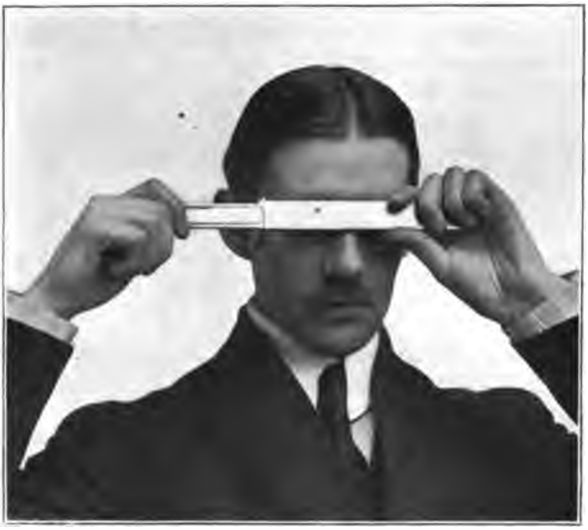

**Figure 3 shows the position in which the photometer is held when in use, resting firmly on the nose, with the hole in the case before the eye.**

vary more than 1/10 of a stellar magnitude from the calculated amount in the quantity of light they cut off. This series of glasses consisted of six pieces which cut off an amount of light equal to 1, 2, 3, 4, 5 and 10 stellar magnitudes, respectively, and by comparing each photometer with this series of glasses, used either singly or in combination, a series of points was established where the instrument cut off an amount of light equal to 1, 2, 3, etc., stellar magnitudes up to 15, and the scales were established uniformly in this way.

The amount of light to be measured, especially in the tests of distant signal lights, was in many cases so much less than a candle power that a scale based on the unit of a stellar magnitude was adopted as being the best. A scale of stellar magnitudes may be stated as a scale of brightness proceeding in geometrical ratio, each magnitude being about 2.5 times as bright as the magnitude next fainter, a difference of five magnitudes being equal to a difference of brightness of the lights in the ratio of 1 to 100. The pole star has a brightness of about 2.12 magnitudes. The ratio of 1 to 2.5 as representing one stellar magnitude has been determined by astronomers by taking the lists of stars which the older astronomers had constructed as giving an estimate of their brightness, as of the first, second, etc., magnitude, and on careful remeasurement finding that a difference of one

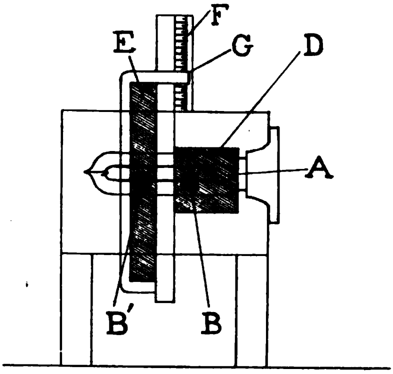

Fig. 4

Fig. 4.—Front plan.

magnitude between one star and another corresponded on the average to the ratio of 1 to 2.5.

In order to make an accurate comparison of the photometric films with the standard shade glasses, I made a new photometer. The problem was to have an intense light, equal to about 17 stellar magnitudes, placed before each of two openings so that each would receive an equal amount of light; behind one of these openings was the standard shade glass, behind the other opening was the photometer film to be measured, and, the light having passed through them, was to be so directed that when seen in the field of the eyepiece part of the field would be lighted by the rays which came through the film, and the other part by the rays which came through the standard shade glass, these two areas just touching along one edge so that their brightness could be compared. By moving the film, a point is quickly found where the light of the two areas is equal, and this shows the point where the film absorbs the same amount of light as the standard glass with which it is being compared.

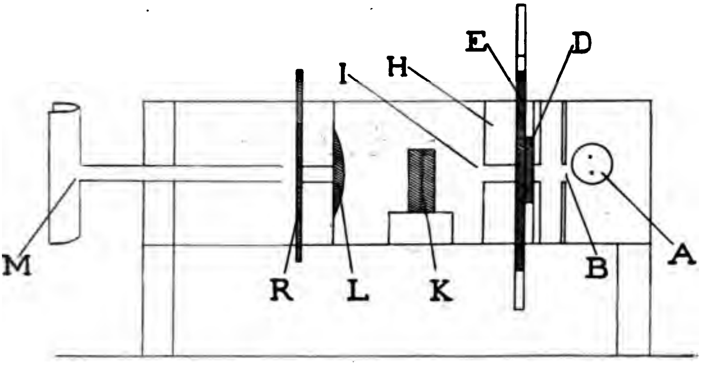

Fig. 5

Fig. 5.—Side plan.

ARRANGEMENT OF COMPARISON PHOTOMETER.

The comparison photometer is arranged thus: In a box (Figs. 4 and 5) about 16 inches long, 4.5 high and 6.5 wide, at one end is a candelabra incandescent lamp with a long straight film, A, which gives an intense and equal light for each of the openings B and B′ in a metal screen, the standard glass D being placed behind B and the photometer film E behind the opening B′. The photometer film E was held in a movable frame so that it could be easily moved up and down vertically to bring any part of the film behind the opening, and a scale F was fixed to the stationary part of the frame so that a pointer G on the movable part would give a reading showing the distance of the point on the film behind the opening B′ from the clear upper end of the film. A partition H in the box cut off any stray light and had an opening I in line with the openings B and B′ in the screen. A prism of twenty degrees K was placed with its apex vertical and 4.25 inches from the openings B and B′ in a line midway between them, and the prism was arranged to move horizontally on the bottom of the box so as to be capable of such adjustment as would bring the edge of the lighted area from one of the openings B in juxtaposition to the other B′ when seen in the eyepiece M. At 2.5 inches from the prism was a convex cylindrical lens L of ten diopters with the axis horizontal, and in the end of the box a tube with a small hole, 1/10 inch in diameter as an eyepiece at the end M, through which the light from the two openings could be seen and compared. The result of this arrangement was to give at the eyepiece M the picture shown in Figure 6. Two light areas O and P are seen, the light of O coming through the opening B′ and the movable photometric film E, the light of P coming from the opening B through the standard shade glass D. If the film is lowered the field O will appear lighter

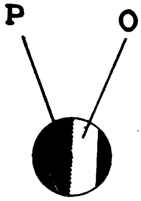

Fig. 6

Figure 6.

than P, and if the film is raised the field O will become darker than P, and a point can quickly be found where, by moving the film, these two lighted areas appear to be of the same brightness, and at this point the scale F is read, giving the distance from the end of the film to the point where the density of the film behind the opening B is just equal to that of the standard shade glass, placed behind the opening B.

In order to act as a regulator and keep the intensity of the light about the same, and at a point where the retina is more sensitive, no matter whether the film E is being compared with lighter shades, of 1 or 2 magnitudes, or with a denser shade of 12 or 13 magnitudes, a second film R covering the whole field as seen in the eyepiece M, is placed behind the cylindrical lens L, and is arranged to move vertically. When the lighter shades are being tested the film R is raised so as to cut off more light, and when the darker shades are tested the film R is lowered so as to cut off less light.

Five readings were taken with the film and shade glass in the first position, then the frame holding the standard glass and film was reversed and another set of five readings was taken in the reversed position. In this way any inequalities in the instrument, such as the light absorbed by the prism, any inequalities in the light from the two openings, etc., were neutralized. The mean of these ten readings was taken to fix the desired points on the paper scale pasted on the glass of the photometric film.

The result of careful measurement of 62 of these photometers has shown that these points when laid off on co-ordinate paper form a practically straight line and, instead of measuring a point on the film for each stellar magnitude from 1 to 15, it is sufficient to measure the position of three points, say 2, 7 and 12 magnitudes, a straight line is then drawn through these three points when laid off, using the stellar magnitudes for ordinates, and the distance from the end of the photometer to the point where the lights are equal for the abscissas, and this will give a line from which the intervening points of the scale can be found with great accuracy.

## TESTS AND RESULTS.

With a "simplex" photometer constructed as above, if we look at the letters on the test-types which represent a vision of 5/50 or 6/60, through the opening in the photometer case, and gradually withdraw the film, we shall find at from 9 to 10 on the scale the form of these largest letters on the test-types has become indistinguishable; in other words, by reducing the light reflected from the test-type card by an amount equal to about ten stellar magnitudes we just cause the largest letters to disappear when the test-types are illuminated by the standard light mentioned at the beginning of this paper. If we find that the largest letters are extinguished before we reach the ten-magnitude point on the photometer, it shows that the illumination of the test-type is more feeble than the standard, but if the photometer scale gives more than ten magnitudes it shows that the illumination is too bright, and by how much.

With the above standard of illumination if we test the point where the line of letters representing average normal vision of 5/5 or 6/6 disappears, we shall find that this corresponds to about 4 or 5 magnitudes on the photometer scale. This would seem to indicate that if we require a certain intensity of light, viz., the standard amount reduced by ten magnitudes, to read the largest letters, V. = 1/10 or 5/50, we require one hundred times as much, or the standard reduced by only five magnitudes, to read the smallest letters, V. = 1 or 5/5. This proportion also seems to hold good for other amounts of acuteness of vision. The distance being, as before, at five meters, and the illumination of standard brightness, the photometer readings for one observer showed normal vision, V. = 1 at 4 magnitudes, V. = 0.5 at 6.5 magnitudes, V. = 0.25 at 7.75 magnitudes. Another observer gave 5, 7 and 8 magnitudes, respectively.

If we reduce the amount of illumination by introducing a given amount of resistance into the circuit of our lamps, say 10 and 20 ohms, we find that for the largest letters, V. = 0.1, or 5/50, we get the results as given in Table 1.

TABLE 1.

| | Full Current. | 10 ohms. | 20 ohms. | |
|---|---|---|---|---|
| Observer .A.. | 10.0 mag. | 8.8 mag. | 8.0 mag. | Right eye. |
| | 10.0 mag. | 9.0 mag. | 8.0 mag. | Left eye. |
| Observer B... | 9.5 mag. | 8.25 mag. | 7.25 mag. | Right eye. |
| | 9.75 mag. | 8.5 mag. | 7.5 mag. | Left eye. |
| Observer C..... | 10.0 mag. | 9.0 mag. | 8.0 mag. | Both eyes. |

This seems to show that as the strength of the current in these lamps is reduced there is a falling off in the amount of light reflected from the test-type card equal to about one magnitude for each 10 ohms. That is to say, for these resistances the reflected light is reduced two and one-half times for each step, and, as the ratio of the intensity of the light increases in geometrical ratio, we find that with the full current the light reflected from our test-type card is two and one-half times as bright as when a resistance of 10 ohms is placed in the circuit and is six and three-tenths times as bright as when a resistance of 20 ohms is placed in the circuit.

The differences in magnitudes and the brightness of the lights are shown in Table 2.

TABLE 2.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Difference in magnitude......** | **0.** | **0.5** | **1.0** | **1.5** | **2.0** | **2.5** | **3.0** | **3.5** | **4.0** | **4.5** | **5.0** |
| **Ratio of brightness...........** | **1.** | **1.6** | **2.5** | **4.0** | **6.3** | **10.0** | **16.0** | **25.0** | **40.0** | **63.0** | **100.0** |

According to this table, if we examine two lights with the photometer and find that one light is just cut off at 3 on the scale, and the other at 5, it shows that there is a difference between these lights of two magnitudes in their intrinsic brightness, and that one light is 6.3 times as bright as the other. If we find that one light cuts off at 5 and the other at 9 on the scale, there is a difference of four magnitudes, and one light is 40 times as bright as the other.

CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# A NEW SUPPLEMENTARY TEST FOR COLOR VISION.*

NELSON MILES BLACK, M.D.
MILWAUKEE, WIS.

The dissatisfaction expressed by those who are required to undergo examinations for color vision is general and in railway service it even extends to the officials. This has created a demand for some test supplementary to the Holmgren wool test which is universally used.

The fact that, in practice, railway men and pilots are dependent at night on light transmitted through colored glass has caused an endeavor to devise a test which shall, as nearly as possible, approximate the actual conditions; hence the lanterns. Many are in general use on a number of our largest railway systems. Dr. Charles H. Williams' lantern is probably the best in this country (Fig. 1).

It is conceded that the worsted test of Holmgren will not detect all kinds of color defects, but it must be also granted that no other known test will, and that the Holmgren test is equal, if not superior, to any yet devised.[1] "An exact test can only be made by the spectroscope by determining the limits of the spectrum and the places of the neutral lines." This, however, is not practical for use in examining railway employés.

The value of the Holmgren test lies in its requirement of a comparison of colors. This is exactly what must be done in practical work; an engineman must draw comparisons between lights of different colors at greater or less distances, with their intensity reduced by atmospheric conditions, by the interference of smoke or steam or by poorly trimmed lamps and dirty lenses and roundels; consequently to meet the demands a supplementary test must conform to several principles which Prof. E. W. Scripture[2] (director of the psychological laboratory of Yale) outlined in his address on "Color Blindness and Its Tests" before the New York Railroad Club:

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

* The semaphore lamps used in railway service being the source of illumination.

[1] Van Marle, F. C.: (doctorate thesis) "The Practical Value of Some Method of Examining Color Blindness." Abstract in Ophthalmology, April, 1905.

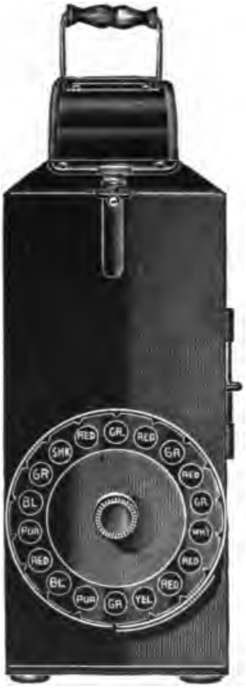

**Fig. 1.—Dr. Charles H. Williams' lantern for testing color vision.**

1. The test must "fit exactly the conditions found in practice."
2. "The person tested should be required to name the objects, for that is what he does inaudibly when he is at work."

---

[2] Scripture, Prof. E. W.: "Color Blindness and Its Tests." Transactions, New York Railroad Club, November, 1899.

3. "The objects for testing should resemble the objects in actual use."

4. "A comparison of colors must be required."

Two more principles should be added and emphasized:

5. The test must give the impression of a signal seen at a distance.

6. The test must be such as may be conducted indoors.

The various lanterns in use fulfill the above requirements to a greater or less degree, but fail in many particulars. "To fit exactly the conditions found in practice," which really includes the fifth principle, "a signal light must be recognized by the engineman at sufficient distance in which to control his train. Mr. R. Quayle, superintendent of motive power of the Chicago & Northwestern Railway, kindly furnishes the following data, which are the result of some recent experiments in controling fast trains: "With the ordinary brake, 70 pounds train-line pressure, a six-car train running 70 miles an hour can be stopped inside of 2,000 feet, approximately 1,900 feet, and when the high-speed brake, 110 pounds pressure, is used on the same train running at the same speed the train can be stopped in 1,450 feet.[3] It will be seen that a signal must be read at not much less than one-half mile (2,640 feet), as a few seconds are necessary for the engineman to shut off his steam and apply his air, and in each one of these seconds a train traveling 70 miles an hour is covering 88 feet."

The suggestion of distance is attempted in the various lanterns by reducing the size of the opening transmitting the light, but this does not by any means meet "the conditions found in practice." as the intensity of the illumination through the small opening is the same as through the large, the source being identical; the only difference is the area of illumination. When the opening is small there are a great many radiating lines of light which give the appearance of a larger opening than really exists.

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[3] Black, Nelson M.: "Vision of Enginemen and Firemen in Railway Service. Some Factors Affecting Same." Official Proceedings Western Railway Club, November, 1904; also, "The Environment and Visual Requirements of Railway Enginemen and Firemen." Transaction of Section on Ophthalmology, A. M. A., 1904, and THE JOURNAL A. M. A., Feb. 18, 1905.

On account of the distance remaining the same with the worsted and lantern tests, there is a certain class of color defectives and *a class most to be feared* that the Holmgren test and any lantern test so far devised will not detect. These are known as chromic myopes.[2, 4] Up to a certain distance their color vision is normal; beyond they can only determine that one color is darker or lighter than another. Such cases the Holmgren worsted test will not detect, nor will the lantern, even with the small opening to simulate distance, unless they are removed beyond the far point for such individual's color sense. Dr. Charles A. Oliver[4] has called especial attention to this fault in the tests now in vogue. The effect on a signal light from atmospheric conditions, smoke, and steam is simulated by using smoke glass of various shades for lessening the intensity, ground glass to represent fog or mist and ribbed glass to simulate rain. These produce the desired effects very well.

"The person tested should be required to name the objects"; it is unnecessary in the test for him to name the color. If the indication is recognized, that is sufficient; for instance, "stop" for red, "clear" for white or green as the case may be and "caution" for green or yellow depending on meaning of colors used. The ignorance of color nomenclature is well known and has many times been mistaken by an inexperienced examiner for color defect.[5]

"The objects for testing should resemble the objects in actual use." The lanterns do, to a certain extent, but many of those examined are suspicious and imagine there is some trick about the lanterns.

"A comparison of colors must be required." Professor Scripture[2] calls especial attention to this important factor in the paper above referred to and suggests: "Three colors at a time is a number agreeable to the subject. It is a fact well established by experimental psychology that under ordinary circumstances the mind can not attend to more than five objects at a time; the number three is well within the limit."

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[4] Wilson, George: "Researches on Color Blindness"; also Oliver, Charles A.: "A Case Illustrating the Inadequacies of the Present Methods for Recognition of Distant Color Signals." Annals of Ophthalmology, April, 1904; also Frank, M.: "Normal and Subnormal Color Perception." Ophthalmic Record, August, 1904; also Eldridge-Green: "Color Blindness"; also Jennings, J. Ellis; "Color Vision and Color Blindness."

[5] Dibble, L.: "Color Blindness vs. Color Ignorance." Railway Surg., vol. x, 1903-4.

Professor Scripture's[2] "color sense tester" carries out this idea of comparison. None of the lanterns I am familiar with do. One or, at the most, two lights are exhibited simultaneously. This does not carry out the fourth principle, but is a fault easily remedied. The color sense tester is not constructed to suggest the impression of distance.

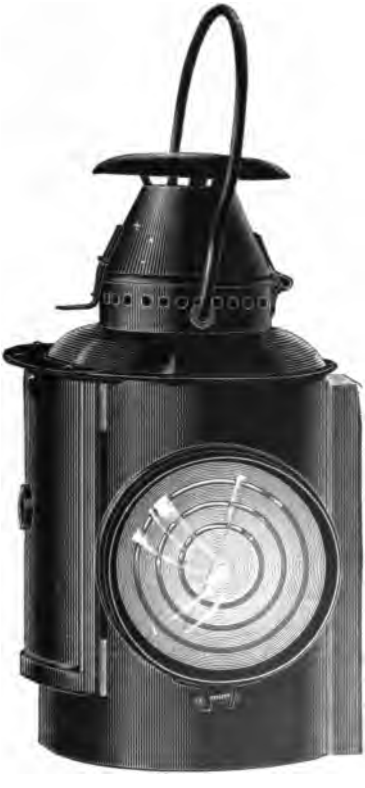

**Fig. 2.—Adams, Westlake & Co.'s non-sweating ventilation semaphore lamp.**

In the test about to be described the optical laws are brought into operation which reduce the apparent size of an object when looking through the wrong end of an opera or field glass. The idea of utilizing this as a supplement to the worsted test was suggested while making comparative range tests of various makes of roundels.[6] This was done with the so-called "reducing lens test" used by Dr. William Churchill[7] of the Corning Glass Works, and it is through his courtesy I am enabled to adapt it for a color test.

The apparatus consists of a brass tube with a dead black lining, about 150 cm. long and 4 cm. in diameter. mounting a combination of biconcave lenses. One end is fitted with a hood similar to that used on the ordinary stereoscope, tapered to size of tube. The tube should be mounted in a screen to prevent the person being examined from seeing the source of illumination. The illumination consists of three Adams, Westlake & Co.'s nonsweating ventilation. standard semaphore lamps (Fig. 2). These are placed 400 cm. from the lens farthest from the eye-piece in the tube and form a right angle triangle, whose base is 225.8 cm. and one side 198.12 cm. from center to center of lenses in the lamps. This conforms to the arrangement of signals on one post in practice according to Mr. L. R. Clausen, signal engineer C., M. & St. Paul R. R., and Mr. J. A. Peabody, signal engineer C. & N. W. R. R. (Fig. 3).

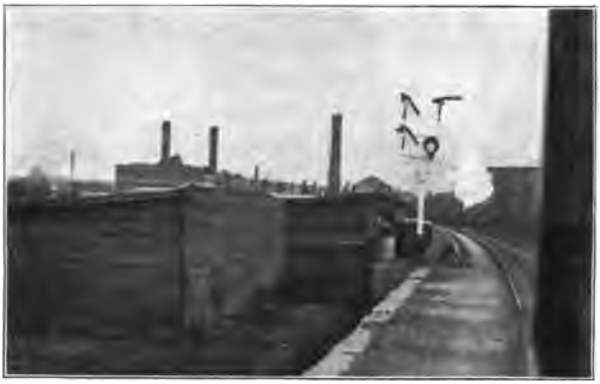

Fig. 3.—Combination disc and semaphore block.

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[6] Black, Nelson M.: "Report of Comparative Tests of Roundels from an Ophthalmologist's Standpoint." Proceedings of the Railway Signal Association, vol. vii, November, 1904.

[7] Churchill, Wm.: "The Roundel Problem." Proceedings of the Railway Signal Association, vol. viii, November, 1905.

The lenses used in the lamps are the latest pattern corrugated semaphore lens manufactured by the Corning Glass Company. This lens collects the divergent rays

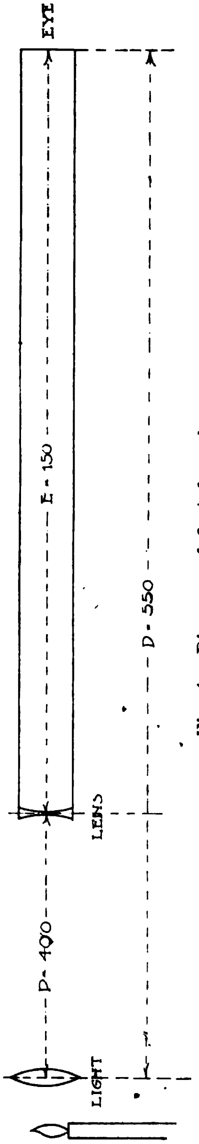

Fig. 4.—Diagram of first formula.

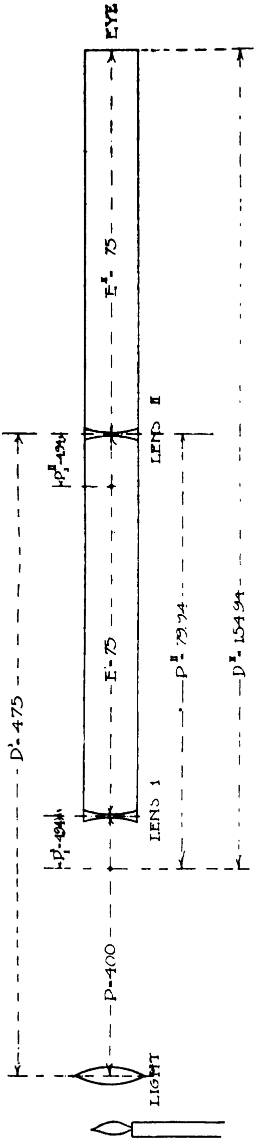

Fig. 5.—Diagram of second formula.

into a nearly parallel beam; it is 5⅜ inches in diameter and has a 3½-inch focus. The fronts of the lamps are fitted with cells very much like those in a trial frame into which the colored glass or roundels used in service may be placed. The colors used in railway service are red, green, white and yellow, but in the test these are used in darker and lighter shades to determine if the candidate can discriminate between different shades of a color.

An attempt to produce the effect of fog, mist, smoke, steam, rain and lowered intensity, due to different atmospheric conditions, is made by interposing ground glass, yellow glass and different shades of smoke glass which produce the desired effect.

The apparent reduction secured may be deduced from the following formula:[8]

$$d^1 = d + \frac{e\,(p)}{f}$$

d = the real distance from the light.
$d^1$ = the imaginary distance from the light to the eye.
e = distance from the lens to the eye.
p = distance from the lens to the light.
f = focal distance of the lens.
The maximum reducing effect would be obtained if e = p.

As every lens reduces the intensity of a beam of light 10 per cent. by reflection, and every reflection in a mirror reduces the intensity 15 per cent., allowance must be made for the loss by the following formula:

$$d^1 = 105.4 \text{ per cent. } d + \frac{e\,(p)}{f}$$

When a second lens (Fig. 5) is used, it is necessary to calculate the distance ($p^1_1$) from the lens to the apparent position of the object or light behind it; this is obtained from the formula:

$$p^1_1 = \frac{p^1(f)}{p^1+f}$$

Then $p^{11}$ of the second lens becomes $p^1$ of first lens + $e^1$ of first lens and $d^{11}$ becomes ($p^1_1 + e^1$) + $e^{11}$ as indicated in the calculation following:

To ascertain the effect produced by two lenses get the apparent distance given by one, then multiply by factor $\frac{d^{11}_{1}}{d^{11}}$ for second lenses as indicated in the calculation.

The following example will illustrate using two — 20 D. lenses, with object 400 cm. from first lens, the lenses

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8. Palaz: "Industrial Photometry."

75 cm. from each other and the eye 75 cm. from the second lens. The formula becomes (Fig. 5):

Lens 1. $d_1' = p' + e'_1 \frac{e' p'_1}{f}$

$d_1' = (400 + 75 + \frac{75(400)}{5})\ 105.4\%$

$d_1' = 475 + 15 \times (400)$

$(6475)\ 105.4\% = 6824.65$ cm.

Lens 2. $p' = p_1' + e'$

$p_1' = \frac{p'(f)}{p' + f}$

$p_1' = \frac{400(5)}{400+5} = 4.94$ cm

$d_1' = p_1' + e' + e'' + \frac{e'(p'')}{f}$

$d_1' = \overbrace{4.94+75+75}^{x'} + \frac{75\ (79.94)}{5}$

$d_1' = 154.94 + 15(79.94)$

$d_1'' = (1354c \text{ or } 8.74d^{\circ})105.4\%$

$d_1' = 9.21d'$

But Lens 1 gives apparent distance of 6,824.65 cm.; therefore, combined effect of the lenses is:

6.824.65 cm. +9.21 cm. = 62,855 cm.
62,855 cm. = 628.55 m. or 2,055 feet.

The test is conducted as follows and may precede or follow the Holmgren wool test, as is desired. If it precedes, it will often indicate what to look out for in the wool test. The person to be examined is shown the semaphore lamps arranged in the triangle with the roundels in place; a clear, red and green or any combination that is used on his road, and is informed he is to state what the signals indicate; he is then seated behind the screen and the lenses placed in the telescope tube to give the lights the appearance of being about one half-mile distance. Several combinations are made which are recorded: Signal No. 1, "danger," "stop" or red; No. 2, "caution," "clear" or green or white; No. 3, "danger" or red, as the case may be. If the candidate wishes to give the name of the color or its indication, it makes no difference. The intensity of the lights may now be varied with smoke, ground or ribbed glass, or one or more of the lights may be blocked out by placing a blank in the cell. If there is some difficulty in interpreting the signals with the apparent reduction equal to one-half mile, arrange the lens to give the apparent reduction of less than one-half of a mile and try same. Other candidates may watch the proceedings, but are not allowed to communicate with the person being examined.

The main reason assigned by Dr. Charles H. Williams[9] for a supplementary lantern test is that "some cases are able to pass the wool test correctly and without hesitation, who when examined with the lights from a distant signal may be unable to distinguish the red or green with any reasonable degree of certainty, and, in fact, often confuse these colors. This occurs most frequently in cases of acquired defect in color vision caused by excessive use of tobacco or alcohol or by a combination of the two. In such cases there is often a small defect in the central part of the retina so small that the retinal image of the skein of worsted is large enough to be formed partly within the affected area, and partly beyond it, and if any part of it falls on healthy retina its color can be at once recognized. If the object is small, like a distant signal light, the retinal image is formed wholly within the affected area, and the color is not recognized. At night there is often no other means of distinguishing between safety and danger, except by the quick and accurate recognition of the color of a railway signal or the side light of a ship, and it is of a special importance that the test for color perception should include a test resembling as nearly as possible the conditions of service and of such a kind as to show conclusively, after the test has been made, whether the person can be relied on to recognize quickly and accurately the color of a distant signal light."

Such cases are rare and it would be natural to suppose that with a relative or absolute scotoma sufficiently large to cause confusion in the recognition of a distant signal, or blot it out entirely, the form vision would be so diminished as to throw out the candidate at once. The reducing lens test will meet the demand in such a case even better than the lanterns will, because of the radiating rays from the small opening. If three lights are displayed and only two seen, or the color not recognized of the third, or the two lights displayed and only one seen, it would lead one to suspect a condition as above described, and further tests should be made to ascertain the condition.

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[9] Williams, Charles H.: "The Need of a Supplementary Lantern Test for the Proper Examination of Color Perception." Boston Medical and Surgical Journal, July 30, 1903.

To summarize: The test fits exactly the conditions found in practice. The objects used in testing are the same used in actual practice, the person tested is required to designate what he sees either by name or to indicate its meaning, which he does in practice. The fault of all lantern tests is overcome by simulating distance, by a relative reduction in the size of the image. The factor which gives the success to the Holmgren worsted test, that of comparison, is followed, the impression of distance is maintained, and the test may be used as an office test. The only thing we can not do is to produce a gale of wind or a rainstorm or the roar and noise of the engine for the benefit of the candidate while being examined.

128 Wisconsin Street.

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PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# NEW PHENOMENON OF COLOR CONVERSION*

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NEW YORK.

It is several years since I first observed and instituted some experiments with an interesting color conversion phenomenon which, so far as I could learn, had previously been unobserved.

After some thought and examination regarding the phenomenon I communicated it to Dr. George T. Ladd, professor of philosophy in Yale University, who, in connection with Prof. E. W. Scripture made some observations in the Yale psychologic laboratory. In Prof. Ladd's report of these joint observations[1] the elements of the appearance were not fully stated and no contribution to the elucidation of its nature or causes was made. I have improved the first opportunity of leisure which has been presented to me for a study of the interesting phenomenon and now present a description with a statement of some of the principles involved in its explanation.

## THE PHENOMENON DESCRIBED.

If, in the midst of a somewhat broadly extended surface of a given color, a narrow stripe of complementary color is seen the narrow complementary color stripe, when viewed with a fixed gaze, will be eliminated from the field to be replaced by the color of the more extended surface. With certain color combinations the phenomenon is more easily observed than with others, and the "fixed gaze" must assume a character which it is difficult to describe but which is absolutely necessary to the color conversion.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

[1] Ladd: "Studies." Yale psychologic laboratory, 1898.

Figure 1 shows a square of green surface, the predominant color, in which is a narrow band of red, the subordinate color, enclosing an oblong portion of the green surface.

The whole figure is divided into small squares by horizontal and vertical white lines which I have found to facilitate the induction of the phenomenon although they are by no means essential to it.

The colors of this particular figure, to be more explicit, are, for the broader expanse, blue-green, full color and red, full color. An excellent combination for the experiment is of orange-red and full color green. Many other combinations may be used, but as we shall see as we proceed, some are more favorable than others and with some combinations it is impossible to induce the phenomenon.

We may change the arrangement of the colors of a pair, making, for example, the red which in Figure 1 is the subordinate color, the predominant one as shown in Figure 2. In this case, however, the phenomenon is not induced with the same ease as in the first instance, and this rule prevails with all pairs that one element yields to the elimination as the subordinate color much more readily than the other.

The comparative illumination of the two colors of a pair is to be regarded. For example, if the composition is of blue and of orange-yellow the latter is so much more strongly illuminated that the phenomenon is difficult and generally impossible to induce. But if we employ a tint of blue and a shade of orange-yellow we have so modified the illumination as to render the induction of the appearance practical and easy. While it is possible to induce the conversion of the color with various complementary pairs properly toned as to the reflection of light, the excessive illumination of one of the elements in some complementary pairs renders the elimination of the subordinate color extremely difficult and in some instances impossible.

The reason for this appears when we consider that the luminosity of the red, such as is used for Figures 1 and 2, is, according to Vierordt, exactly the same as that of the bluish-green of these figures. These two colors constitute the pair which lends itself most readily to the phenomenon. On the other hand, of the complimentary pair, blue and yellow-orange, the latter, under circumstances of good light, has about sixteen times more illumination than the former.

While for the perfection of the experiment complementary colors are to be used, some other strongly contrasting colors may be employed with a more or less approximately successful result. Thus, a full red band in a field of full blue color will become very nearly of the color of the broader field, yet in this case there remains, to some extent, the phenomenon of simultaneous contrast of which mention will be made later. In all these experiments the band of subordinate color should be narrow. About two millimeters is a favorable width in a square of the size shown in Figures 1 and 2, and it should be surrounded on all sides by the predominant color.

I have already remarked that I have found that breaking the larger surface and the bands into small squares by white lines promotes the ease of inducing the change of color of the band. Why this is so I am unable to explain, unless, as it will be seen as we advance, it may be easier to adjust the accommodation for the white lines which requires an effort in excess of that for the red surface and less than that for the green and that thus one may be aided in adjusting the accommodation for a point between what would be the point for clearest adjustment for the red and that for the green, an act which we shall see is necessary to the success of the experiment.

### WHAT IS THE EXPLANATION?

In explanation of the phenomenon we may first consider in connection with it several known principles which might be suggested as causes, but all of which, on careful examination, we shall have to reject. We may premise that it is not a color illusion but an objective phenomenon.

Let us consider first the principle of simultaneous contrast. The principle has been stated as follows: "If we look simultaneously on two stripes of different tones of the same color, or on two stripes of the same tone of different colors placed side by side, if the stripes are not too wide, the eye perceives certain modifications which in the first place influence the intensity of the color, and in the second, the optical condition of the two juxtaposed colors respectively. . . . They will appear as dissimilar as possible, both in the optical composition and in the height of their color."[1]

In all experiments of simultaneous contrast which are mentioned in works on color we find that the results differ absolutely from the phenomenon of conversion of color under consideration. For example, if orange and green are placed side by side the orange assumes a more brilliant red and the green a more luminous bluish green.

In Figure 3 we have an illustration of the principle of simultaneous contrast in which exactly the same colors as those which I have used in the experiment of conversion are employed. In Figure 3 the red central disc is too broad in proportion to the extent of the predominant field of green to permit of the conversion except with the greatest difficulty, but the phenomenon of simultaneous contrast is at once seen in the lighting of the green with a yellowish luminosity and a deepening of the red.

In the phenomenon of conversion under discussion if the predominant color is green, as in this case, this color will remain without modification, while the red will be completely eliminated and replaced by green of the exact shade of the general field. We may without further consideration dismiss this principle as an explanation of our phenomenon.

So also the principle of successive contrast or after images of complimentary colors must be rejected and the suggestion of fatigue of the retina need not be considered. Then also we may eliminate the principle of irradiation since irradiation becomes more marked in proportion to the contrast in illumination of the elements of objects and background, whereas in the case of the color phenomenon under consideration a certain degree of uniformity of illumination of the two colors is essential to its manifestation.

Our phenomenon reminds us of that known as the phenomenon of Purkinje and of that of Troxler, which last, however, is less a phenomenon of color than of form. Perhaps the experiment most nearly comparable to this is that of Ragona Scina. These and several known principles, when carefully considered, afford no explanation of our phenomenon, nor does it find a place under any

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1. Chevreul: "Color," p. 71.

category of phenomena which, so far as I have learned, have been heretofore described.

### PRINCIPLES INVOLVED.

I venture to suggest two principles which are undoubtedly involved in the phenomenon and which appear to me to be elements in its explanation. They do not, however, complete the explanation, but lead, probably, toward it. Of these two elements, which I think may properly be included in the series of causative principles contributing to the phenomenon, the first to be mentioned is the difference of refraction of the various colored rays entering into the experiment.

Owing to the difference of wave lengths of the two colors which may be employed the refraction of one set of rays as they pass through the media of the eye must be greater than the other. Sir Isaac Newton observed that, with the source of illumination at six feet from his lens, blue rays converged an inch and a half nearer to the lens than red rays. Hence, if the accommodation of the eye were to be adjusted precisely and fixedly for the green rays of Figure 1, the red rays would only be converged for a point considerably behind the retina.

This brings us to the second element which may safely be regarded as contributing to our phenomenon. It is the adaptation of the eye through the act of accommodation to a place in advance of the surface on which the two colors are imprinted. If the accommodation is thus adjusted in looking at the two colors let us suppose those of Figure 1, with the green rays converged somewhat in advance of the retina and the red rays for a point which would lie somewhat behind the retina, a phenomenon will occur which is of much interest. It will be seen by examining the diagram, Figure 4, that the green rays will twice cross the red ones and reach the retina diffused.

What happens as the result of this crossing of rays is a question of difficulty as well as of interest to which we may refer when we have studied the phenomenon under other circumstances.

If we reverse the relations of the colors of Figure 1, using the green for the narrow interior band and the red for the greater surface, as in Figure 2, a complication at once arises. The conversion which, with the first arrangement, was induced with ease now becomes a matter of very considerable difficulty, and many persons who succeed in effecting the conversion with the first arrangement are unable to accomplish it with the second. Since we have the same colors and the same comparative illumination the question naturally arises why should there be greater difficulty in one case than in the other?

If it is true that the difference of convergence of the two classes of colored rays and the act of accommodation are elements in our problem we may receive an answer to the question, and it is the only answer that has occurred to me, from examining the diagram Figure 5, where the complications at once make themselves manifest.

Here the relations of the colored rays are the reverse of those in figure 4. The red rays which converge only at the longer distance from the lens now occupy the outer ranks in the groups of rays approaching the eye. The now central green rays converge first and the red peripheral rays pass them by at first without crossing. It is only after the green rays have converged and have become again diffused that the first crossing could occur, and a second, if it should occur at all, could only occur behind the point of convergence of the red rays.

The difficulties then of inducing similar conditions of retinal impressions when the relations of the color spaces are reversed can be readily seen, and this principle holds good for all color pairs. In every instance the color whose wave length is shortest and therefore whose rays converge most is the color which, as the predominant or outside color, is best adapted to the experiment, while the companion color as the predominant one always presents a difficult combination and with some pairs in which the conversion can be made with the longer wave color as the subordinate it is quite impossible to induce the conversion phenomenon when the shorter wave color is subordinate.

These two factors, the differences of the refractive character of the two colors and the adaptation of the eye through the accommodation to certain conditions of refraction may, it would appear, be accepted as elements of the phenomenon, but there remains a factor or perhaps more than one factor still undetermined.

Some recent experiments may suggest the direction in which we are to look for the missing element or elements. On my library table stands an electric lamp enclosed in a large globe of corrugated glass. I take from a sheet of transparent "isinglass," a gelatine material such as confectioners use for enclosing bonbons, a strip an inch and a half wide by about five inches long. I hold it before my eyes and look at the globe. It is a rich, brilliant bluish-green. I take from another sheet a strip of similar proportions, and on looking at the globe through it the globe takes on a full deep red color. I now place one of these strips on the other, and on looking through find that the globe presents a deep red color, with the illumination so greatly reduced that the corrugations can hardly be seen and a sheet of white paper on the table near the lamp is so indistinctly seen that its borders can with difficulty be made out. All this is exactly as we should expect. I now take a strip of red about three millimeters wide and an inch or two inches long and place it on the original green strip. At first I see the general form of the globe of a fine green color and across it a dark red stripe through which no details of the surface of the globe are seen.

Presently, as I make an adaptation of the accommodation, the red stripe becomes green of the same color as that of the general appearance of the globe, but while not appearing of a lighter tint, it has a more pellucid and transparent appearance and is in fact more transparent, for the corrugations of the glass are seen more plainly through the layer of red and green than through the single layer of green. The corrugations also appear somewhat magnified, and I seem to see them not only through the transparent window but in advance of it.

Again, with a steel punch I make a circular opening in the broad strip of green and in it insert a disc cut by the same punch from the red. In the back of a large camera I place an electric light and in place of the lens a screen with an opening one-fourth of an inch in diameter. In front of this is a screen of white paper. If, holding a strong lens in my hand, I condense the beam of light to a focus on the screen and then bring it slightly backward toward the camera and then interpose the isinglass strip with the little disc of red exactly in the axis of the lens there is on the screen a small image of the red disc with a surrounding of green, but moving the strip backward and forward, keeping the little disc in the beam of light, I find, first, a point at which only a bright green beam passes through the strip with only a faint pink blush much diffused and hardly discernible in the field of green, and second, at another point, a green expanse surounded by a halo of red.

In the last instance we have, of course, a dispersion of the red rays. In the first instance there is a dispersion of the green rays which come to occupy a central as well as a peripheral position. In what manner the red rays are modified, whether by the ascendant influence of the other rays as, for example, when we look at the rotating Maxwell's disc in which, of the two colors red and green the latter occupies 80 per cent. of the surface, no suggestion of red is seen and the green is so slightly modified that the modification is with difficulty discernible, or by a modification from some form of non-destructive interference I am not ready to assume.

While the experiment with the lens fails to reproduce the conditions in the eye in an absolute manner, it approaches it very nearly.

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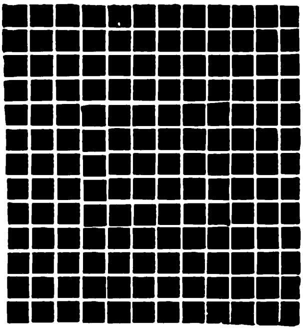

Figure 1

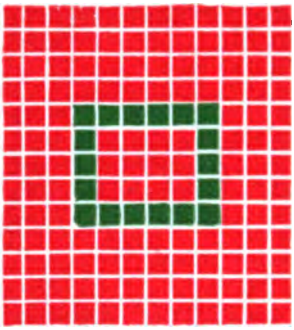

Figure 2

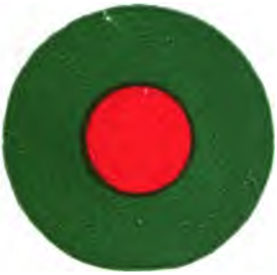

Figure 3

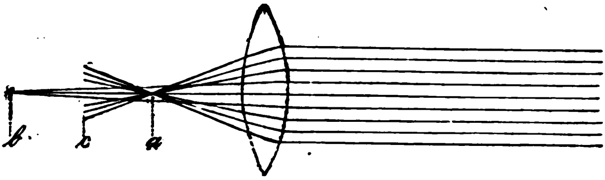

Figure 4

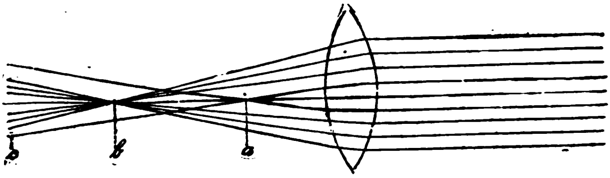

Figure 5

# DENDRITIC KERATITIS OF MALARIAL ORIGIN.*

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Among the less common diseases of the cornea is that known as dendritic keratitis, to apply the name which its appearance suggests, or mycotic keratitis, a name more in accord with its etiology. This disease appears, when fully developed, as a finely branched ulceration of the cornea, running a rather protracted course. In my personal observation it has almost always appeared as a complication of acute malaria, though the same picture has been occasionally seen in patients who had no malarial manifestations, and who had not suffered from malaria at any time sufficiently recent for it to have any possible bearing on the eye trouble.

The disease is not common. Even in malarial districts it is not one of the commoner eye diseases, and when compared with the large number of persons who have malaria, it is seen to be an unusual complication of that disease. I can only state the case thus vaguely, as I have no means of arriving at accurate statistics. The following remarks apply to its characteristics as seen by me:

It is decidedly more common in the late summer and fall, corresponding to the time of the greatest prevalence of malaria. It is rare to have an opportunity to see it prior to the ulcerative stage, though Kipp of Newark has described it as beginning as a series of small subepithelial lymphoid papules, which quickly break down just as phlyctenulæ may do. Judging from the size of the lesions when it is what might be called fully developed, these initial papules must be of almost microscopic size. The rapid coalescence of several lesions results in a fine shallow linear ulcer, with a tendency to branch, this giving the characteristic dendritic arrangement. The amount of infiltration of the surrounding tissue is variable. Often the lesion is merely an abrasion of the epithelium, this being especially true of recent lesions, but frequently it has a gray border or base rendering it more conspicuous. A proper conception of its extent only can be obtained by staining with fluorescin. We might even say that the characteristic arrangement of the ulcer is not suggested until made conspicuous by staining. When seen in the earlier stages, with the ulcer involving the epithelium only, and arrested by Bowman's membrane, the unstained cornea fails to show any more than a little roughness. Later, the infiltration of the substantia propria at least suggests the character and extent of the condition, but at all stages fluorescin definitely outlines the denuded area so clearly and so sharply as to present a picture which can hardly be confused with anything else.

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Late in the course of the disease and possibly somewhat influenced by treatment, if energetic, the loss of the epithelium may become very considerable, as much as one-half of the cornea being denuded. I have never seen the lesions suppurate, and while a moderate degree of iritis may occur, it is never more than moderate, and hypopyon is never seen. The lesion is rarely or never multiple. No matter how extensive, it will be found that the ulceration is all a part of a single system or tree, though as healing progresses the bridging of the ulcer here and there may leave separate denuded areas. The history is always given of a preceding chill or chills. It is very rare in chronic forms of malaria and in those unaccompanied by chills. The course tends to be protracted when untreated. In spite of treatment some cases will last for weeks or even months, the corneal picture changing daily. One attack predisposes to others, but one attack is not necessarily followed by others. Still I have seen many patients in whom every attack of malaria "settles in the eye." From the superficial character of the lesions, serious damage to the cornea is not unusual. Nebulæ are usually left, and if central or nearly central, the opacity itself and the resultant irregular astigmatism frequently reduces the vision to from 20/40 to 20/100. That the changes of curvature are a more potent factor in this result than the opacity, is shown by the improvement of vision by cylindrical lenses. It is rare for both eyes to be attacked, even when the disease recurs.

The subjective symptoms are usually marked, the sensation of a foreign body being present, with some deeper aching pain. I have not noticed the supraorbital neuralgia at the beginning, of which Kipp speaks, but neuralgic pains in all the branches of the fifth are not rarely present during the course of the attack. Some patients suffer very little. The ball is injected and photophobia usually marked. It can not be said that there are any characteristic changes in the sensibility of the cornea. The tension is not altered.

It seems to me that this is not the disease described by Horner as herpes corneæ, but is the same, as Kipp suggests, as that described by Hansen Grut and Emmert under the name of dendritic keratitis or keratitis exulcerans dendritica mycotica, respectively. It is convenient to tell the patient he has "fever blisters on his eye," but from the observations which it has been possible to make on this disease in its early stages, and from watching its development and the formation of new buds and off-shoots from the original furrow, I am satisfied that the lesions are not vesicular, but are subepithelial lymphoid collections, resembling phlyctenules, but very much smaller. As far as my personal observation goes, I have only seen this corneal lesion in its typical form in one case where no malarial history was given, and that case ran an unusually mild course. It may or may not be associated with labial herpes, and there is no possibility of confusing it with herpes zoster ophthalmicus. The blood examinations have, with the one exception mentioned, confirmed the existence of malarial infection of the tertian or quartan variety, or in case the plasmodia had been removed by quinin, the equally characteristic corpuscular changes were found.

In common with herpes, the lesions are probably trophic, and could the point be determined, I believe we would find the lesions to develop along the course of the corneal nerves. If we recall the arrangement of the nerve fibers in the epithelium and anterior layers of the cornea, we will be struck with the fact the curved and irregular shapes of the lesions in dendritic keratitis correspond pretty well with the course of these nerve fibers. The fact that the corneal nerves lose their neural sheaths after penetrating about 1 mm. from the cornea-scleral junction, suggests a reason why the lesions under consideration rarely, if ever, reach to the edge of the cornea, but affect the area where the fibers are not protected.

I can add nothing material to what has already been written in regard to the therapeutics of this disease. The general condition always requires treatment, and a change of climate may be necessary. This is not sufficient, in most cases, without local treatment, to relieve the ocular conditions, and I might go a step farther and say that I have seldom, if ever, seen any striking results, as far as the eye is concerned, from the administration of quinin. Yet it is undoubtedly a necessary part of the treatment, not acting as a specific on a specific lesion, but just as a tonic and other similar treatment will do on other forms of corneal ulcers. Similarly, iron may be needed for a postmalarial anemia, and in every way the general condition should be made as good as possible. Very valuable help can be obtained in this direction by blood examinations. Complete removal of the plasmodia from the blood by quinin having been accomplished, the keratitis may still persist for weeks. As far as local treatment is concerned, an antiseptic wash and atropin should always be used and the eye protected. I have not seen any positive results from dionin. The most striking results will often follow the application of tincture of iodin to the ulcer. The eye is well cocainized, the ulcer outlined by staining, and then gone over with a probe armed with a small amount of cotton wet with the tincture. In spite of the cocainization and immediate irrigation, the application is very painful, and is sometimes not at all beneficial. When it does not help matters, the mildest measures are advisable. Hot applications are beneficial and grateful to the patient. A poultice seems to help at times, though the same result can be attained in a more cleanly manner by hot gauze compresses. Some years ago a patient on whom I had tried all the usual methods of treatment without benefit, went on a business trip to a levee camp. On the advice of an Italian laborer he put a garlic poultice on the eye over night. Next day he was practically well, but I have never had another patient who cared to try the same prescription.

As soon as the epithelium is firmly regenerated, the yellow oxid ointment or some similar preparation should be used to lessen the opacity. The refraction should be gone over at intervals, and the corneal changes followed up by suitable changes in the lenses. The astigmatism very frequently causes discomfort on use of the eyes which glasses will relieve.

# UNIOCULAR INFLAMMATIONS OF THE OPTIC NERVE AND RETINA.*

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Ophthalmologic text-books are nearly or quite silent in regard to uniocular inflammation of either the optic nerve or retina, and the cases reported in ophthalmologic literature are not numerous.

Galezowski[1] was, perhaps, the first to assert the unilateral occurrence of certain forms of retinitis, followed later by reports of cases by Henry Power,[2] Jonathan Hutchinson,[3] Leber,[4] and by others, occasionally, up to the present time. A. Yvert[5] and others have reported cases of uniocular retinitis due to albuminuria. Retinitis resembling that of albuminuria, but limited to one eye and without albuminuria, has been seen several times. Williamson,[6] Manchester, England, found five cases of uniocular retinal changes (hemorrhages and inflammation) in thirteen cases of cerebral vascular lesions. In all but one of these cases the retinal disease was on the side opposite to that of the brain lesion. In 1886 Dr. Hughlings Jackson[7] said that he had seen three cases of uniocular optic neuritis in hemiplegics, the neuritis being on the side opposite to the cerebral lesion. Several cases of uniocular optic neuritis have been seen in connection with orbital inflammation and tumor of the same side or with disease of a contiguous sinus (De

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[1] L'Union Médicale, Paris, 1864.
[2] Royal London Ophth. Hosp. Rep., London, vol. vii, 1871.
[3] Royal London Ophth. Hosp. Rep., London, vol. viii, p. 44.
[4] Graefe-Saemisch Handbuch, first edition, 1877, vol. v.
[5] Recueil d'Ophth., March, 1883.
[6] Brit. Med. Jour., June 11, 1898.
[7] Ophth. Rev., vol. v, 1886, p. 24.

La Personne,[8] Peuch,[9] Brailey,[10] and others). Königshofer[11] reported a case of uniocular optic neuritis which disappeared only after the removal of adenoid vegetations. Single cases of uniocular optic neuritis attributable to various remote causes have been reported by Henry Eales,[12] Henry Juler,[13] Charles Higgins,[14] L. Werner,[15] and by others. Dr. de Schweinitz,[16] in 1896, reported five cases of uniocular optic neuritis in patients with histories, respectively, of rheumatism, syphilis, chlorosis, albuminuria of pregnancy, and degenerative changes in the vessels of the optic nerve. C. G. Lee[17] has reported "four interesting cases of monocular optic neuritis" in which it was impossible to attribute the inflammation to any of the causes usually given. Nettleship[18] has collected, under the head of "unilateral retro-ocular optic neuritis," twenty-eight cases "characterized by failure of sight limited to one eye, often accompanied by neuralgic pain about the temple and orbit, and by pain in moving the eye." In these cases, he says, "acute inflammation seems to take place in some part of the course of the optic nerve." The same class of cases has been referred to by Leber,[19] by Hoch,[20] of Vienna, and by others.

While this list of references is not complete, it suffices to show that the recorded cases of this kind are by no means numerous. My own clinical observations on this subject, therefore, may be of some interest. They extend over the past fifteen years and include eighteen cases. These cases are here described in more or less detail, varying according to the facts noted when the consultations were made. Unfortunately, these are, in some cases, rather meager, for at the time I had no intention of publishing them. I trust, however, that my experience will at least serve the purpose of directing professional attention more earnestly to this subject.

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[8] Arch. d' Ophth., vol. xix, p. 518.
[9] Jour. de Med. de Bordeaux, April 5, 1891.
[10] Ophth. Rev., vol. vi, 1887, p. 24.
[11] Ophth. Klinik., January, 1901.
[12] Trans. Ophth. Soc. of the United Kingdom, vol. v, 1885, p. 126.
[13] Trans. Ophth. Soc. of the United Kingdom, vol. xiv, 1894, p. 121.
[14] Lancet, April 22, 1899, p. 1083.
[15] Trans. Ophth. Soc. of the United Kingdom, vol. xxv, 1905, p. 93.
[16] Phil. Polyclinic, Dec. 12, 1896.
[17] Brit. Med. Jour., vol. i, 1902.
[18] Trans. Ophth. Soc. of the United Kingdom, vol. iv, 1884, p. 186.
[19] Graefe-Saemisch Handbuch, first edition, vol. v, p. 829.
[20] Hirschberg's Centbl., April, 1884.

I shall arrange my cases into three classes; first, those of uniocular optic neuritis; second, those of uniocular neuro-retinitis, and third, those of uniocular retinitis.

### UNIOCULAR OPTIC NEURITIS.

CASE 1. Optic neuritis in left eye; mild, duration short, mild recurrence, recovery.

*Patient.*—Miss M. S., Batavia, N. Y., aged 16, is a well developed, healthy girl from a well-to-do family. She menstruates regularly and without pain, and has no abnormal condition of the urine. She consulted me on March 9, 1893, complaining of not seeing as well as usual with her left eye, and of seeing "black spots before her eyes." This condition had existed about two weeks.

*Examination.*—This gave vision of the right eye 5/5 Snellen, left eye 5/15. There were several scotomata in the visual field of the left eye. With the ophthalmoscope the right fundus was seen to be perfectly normal, while the left showed a distinct picture of mild optic neuritis. The optic disc was slightly obscured and a little swelled. The retina near the optic disc was edematous. There were no retinal hemorrhages or exudates.

*Treatment.*—She was given iodid of potash internally, and on April 8 the vision of the left eye, like that of the right was 5/5, and the optic disc appeared clear and normal.

*Recurrence.*—May 5, 1894. Miss S. had a recurrence of the old trouble in her left eye, which she felt during the past week. The optic disc was again slightly inflamed, with the same appearances as those of nearly a year before. Vision was reduced to 5/25. The urine was normal, and the patient seemed to be healthy. She was again given potassium iodid and rapidly recovered. The eye has remained well since that time.

CASE 2.—Optic neuritis in right eye, rather severe, duration eight months; recovery with vision equal to 5/6.

*Patient.*—On April 27, 1902, Mrs. F. M., Olean, N. Y., aged 28, was referred to me by Dr. C. S. Bull, of New York, with a letter in which he said: "Mrs. M. has an optic neuritis of the right eye, with engorged veins, but not much infiltration, and no signs of 'choked disc.' The vision was 20/40 in this eye, and normal in the left eye. She has a hypermetropic astigmatism of slight degree in both eyes. There were no retinal hemorrhages. There was no limitation of the visual field, and no scotoma present, either for form or color." He prescribed "mixed treatment."

*History.*—Mrs. M. is a well-nourished, healthy-looking young woman of medium height and weight, and with a history of no continuous headaches, or recent sickness of any kind. She has one healthy child. She has had no urinary or kidney affection.

About four weeks before her first visit to me, she noticed a confusion of vision in reading, and found that the vision of the right eye was not as good as that of the left. She at once consulted an ophthalmologist in Buffalo, but afterward went to New York and consulted Dr. Bull, who reported to me the condition quoted above, together with an analysis of the blood and urine, which were normal.

*Examination.*—On April 27, 1902, the date of the first visit to me, the right pupil was dilated with atropin sulphate solution. The vision without a lens was 5/30; and with + 1.D. sph., 5/20, and not further improved by any cylindrical combination. Ophthalmoscopic examination showed nearly the same appearance as described by Dr. Bull: optic disc slightly "woolly" and swelled, its outlines obscured, and the vessels dilated and abnormally tortuous. There were a few minute hemorrhages near the disc, but no exudates of the retina.

The fundus of the left eye was absolutely normal, and the vision of this eye was 5/4, nearly.

*Treatment.*—Dr. Bull's treatment was continued, except that the instillations of the atropin sulphate solution were omitted. The patient was advised not to use the eyes, and to protect them from the light by colored glasses.

May 8: The effects of the atropin solution in the right eye were nearly gone. Vision was 5/20, also with + 1.D. sph., that of the left eye was 5/4, minus. The same internal treatment was continued.

May 24: The appearances of the right optic disc and surroundings were improved. Vision was the same as before, 5/20.

July 2: Inflammation of the right optic disc was much less. Hemorrhages of retina had become absorbed, leaving no visible lesions. Vision was 5/15.

There was a steady improvement of the neuritis of the right optic nerve until Dec. 12, 1902, when it was nearly clear in its outlines, and of good color. At this date the vision was 5/6.

Feb. 9, 1903. The record says: "Fundus of right eye is perfectly normal. Vision is 5/6, plus." Treatment was suspended.

Aug. 11, 1903, also Feb. 27, 1906. There was, perhaps, a slight "roughness" of the outlines of the right optic disc, but it was apparently normal in color, certainly not pale, and the vision was 5/5, nearly. There were no lesions at the macula lutea. The left fundus remained normal, and vision of this eye was 5/4. There was slight astigmatism in each eye. The urine has never been abnormal, and the patient seems in perfect health. There is no history of syphilis. The only complaint is an occasional headache.

Case 3.—Optic neuritis in right eye, considerably severe, duration six months; recovery with slight pallor of the disc, and vision 5/6.

*Patient.*—A. B. P., Buffalo, N. Y., a man of medium size and weight, aged 43, married, had always enjoyed good health, and has had neither syphilis nor albuminuria. He was brought to me by Dr. John Mesmer on Jan. 27, 1905. About fifteen days before, while reading, his right eye began to give him pain and the vision of that eye also became quite dim. He consulted Dr. Dennett of New York, who examined him carefully and referred him to me with a chart of the visual field of the right eye taken January 18, showing that it was very much narrowed, except directly outward, and with a note stating his diagnosis of optic neuritis of this eye.

*Examination.*—My own examination with the ophthalmoscope showed a typical picture of optic neuritis of the right eye, disc swelled and outlines obscured, and the vessels considerably engorged. There was no special involvement of the retina, and there were no retinal hemorrhages. I found the visual field much contracted, except directly outward. Vision was 5/15. As stated above, the patient's general health was good, except that he was "very nervous." There were no symptoms of brain or spinal cord disease. The pupil of the right eye was of the same size as that of the left, and responded normally to light.

The left eye was normal in every respect, and the vision was 5/5.

*Treatment.*—Dr. Dennett had prescribed strychnia, gr. 1/60, three times a day. I advised the substitution of moderate doses of potassium iodid.

*Result.*—I did not see the patient again until June 21, 1905, when, in consultation with Dr. H. C. Buswell, I examined him again. At this time the optic disc had entirely cleared up and the color was apparently normal, possibly a trifle more pale than the left optic disc. The vision was 5/6. The visual field had not materially changed since the last visit. The left eye continued normal both in structure and vision.

*Remarks.*—Dr. Buswell, Dr. Mesmer and I were unable to find a sufficient cause for the uniocular optic neuritis in this case. Dr. Dennett believed the cause to be arteriosclerosis, but Dr. Buswell decided that there was no arteriosclerosis, and in this he says he was supported by Drs. Edward Janeway and Herman Knapp of New York, after a thorough examination.

CASE 4.—Retro-ocular optic neuritis in left eye, very severe, blindness for nine days, duration six months; recovery, disc pale, color sense impaired, light sense diminished, vision 5/7.

The following case has been reported[21] under the title of "Hysterical or Functional Blindness." I am convinced, however, that it belongs to the class of uniocular retrobulbar optic neuritis described by Nettleship and referred to above. I, therefore, take the liberty of reproducing it here.

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[21] Trans. Amer. Ophth. Soc., 1897.

*Patient.*—Miss J. H., Angelica, N. Y., aged 18, consulted me on March 16, 1897.

*History.*—She stated that on March 9 she was seized with pain in the left eye, which extended over the left side of the head and into the left ear. This was so severe as to require anodynes for its relief. In three days it had nearly disappeared. Soon after the onset of the pain, the vision became affected and on the next day, March 10, it was very "foggy." On awakening on the morning of the third day, March 11, she found that the vision of this eye was lost, she not being able to distinguish even light with certainty. An ophthalmologist in a neighboring town was consulted and after examining her gave a diagnosis of "retinal thrombosis." He prescribed treatment which was followed for a few days without improvement. Her father, who was a physician, became anxious, and desiring further advice, brought her to me.

*Examination.*—External examination of the eyes showed them to be alike in appearance, and their movements were normal. The pupils were normal and equal in size, but the reaction to light was a little slower and less complete in the left eye than in the right, there being a slight dilatation when exposed alone. There was manifest hypermetropia of 0.5 D. sph. in the right eye, with vision 5/4. The vision of the left eye seemed entirely lost. Careful ophthalmoscopic examination of the left fundus (the pupil being dilated with homatropin solution) showed no pathologic change whatever. There were no obstruction in the retinal circulation or change in the vessels, no edema, discoloration or hemorrhage of the retina, and no changes of the optic disc. Tension was normal. The patient complained of some headache, a "weakness" of the eye, and general weakness. I ventured the opinion that the case was one of so-called functional blindness, but suggested that another opinion be obtained; accordingly, on the next day, March 17, my friend, the late Dr. F. W. Abbott, examined the patient most carefully with the same result that I had found, except that he thought there was a slight engorgement of the retinal veins.

*Treatment.*—Dr. Abbott suggested that a leech be applied to the left temple, and that the patient be kept quiet in a darkened room for a few days. This was done, and five grains of potassium iodid were given three times a day. Later strychnin, 1/60 gr., was given three times a day.

*Course of Disease.*—March 19. There was a distinct perception of light, and she could see the movements of my hand.

March 20. She counted fingers held in the peripheral part of the visual field with difficulty.

March 28. She read 1/60 eccentrically.

April 3. Vision equaled 5/60, eccentrically. Ophthalmoscopic examination showed fundus normal as before. Patient returned home with directions to continue essentially the same treatment as before.

April 15. Examination showed that the vision had increased to 5/9, and Jaeger No. 6 slowly at 10 inches.

Her vision gradually improved and in June she was able to read No. 1 Jaeger with some difficulty. The optic disc was abnormally pale, the color sense was somewhat impaired, and light sense was diminished.

In February, 1906, I again saw this patient and found the vision of her left eye to be 5/7. The disc appeared a trifle pale, and the color sense and light sense were still somewhat impaired.

About two years previous to this attack she had had malarial fever, but fully recovered from it and has since enjoyed good health. She had no uterine disorders or trouble of any kind.

### UNIOCULAR NEURORETINITIS.

CASE 5.—Neuroretinitis in left eye, severe, duration over a year, loss of vision, neuroretinal atrophy. General health fair, evidence of general arteriosclerosis.

*Patient.*—Mrs. E. E., a farmer's wife, aged 61, presented herself to me through the advice of the late Dr. H. D. Ingraham, on October 13, 1892.

*History.*—The sight of the left eye had been failing for about a year. There had been no pain in the eye or head, but in addition to the failing vision, there had been a great deal of photopsia in this eye—"flashes of light and shooting stars." Centrally the vision was destroyed, but beyond about 10 degrees, throughout the visual field, she could count fingers.

*Examination.*—Examination with the ophthalmoscope showed swelling of the optic disc, with indistinctness of outlines, diffused haziness of the retina, engorged retinal veins, and tortuosity of both the retinal veins and arteries, and numerous retinal hemorrhages near the optic disc, and several smaller ones farther away. At the macula lutea, and also inside and below the optic disc, there were several whitish spots of considerable size.

The vision of the right eye was not as acute as formerly, and equaled 5/18. There was no inflammatory process in the fundus of this eye. The vessels, however, were diminished in size.

*Treatment.*—This woman's health was not good and there was some evidence of arteriosclerosis. The kidney secretion was normal, and there was no albumin in the urine. She was put on moderate doses of potassium iodid.

*Course of the Disease.*—On November 12 the optic nerve and retina of left eye were still much inflamed. There was no fundus inflammation of right eye. The same treatment was continued.

March 17, 1893. The left optic disc and retina were still much inflamed and there were whitish spots below and to the inside of the optic disc.

Aug. 9, 1902. The retinal hemorrhages and exudates had disappeared, and the optic disc had become atrophic. The vitreous humor was somewhat hazy. Vision was a little more than perception of light. The vision of the right eye was still poor, but there were no fundus lesions to be seen.

CASE 6.—Neuroretinitis in left eye, considerably severe, duration six months, restoration of vision, no visible lesions remaining, segmental scotoma. Purulent inflammation of right kidney, with some albumin, followed by recovery.

*Patient.*—R. W., Friendship, N. Y., aged 24, a patient of Dr. H. C. Buswell, applied to me for advice on Dec. 7, 1897, regarding impairment of vision in his left eye, which he had noticed for about three weeks.

*History.*—I had examined his eyes two or three times before for hypermetropia, and aside from this error they had been normal, vision being 5/5 in each eye, both without glasses, and with +1.75 D. sph.

The patient was somewhat debilitated from a purulent inflammation of his right kidney from calculi, with occasional discharge of small quantities of pus and blood with the urine, in which there was some albumin and casts. There was an entire absence of symptoms of brain or spinal cord disease. He had occasional headaches, as he had done all of his life, and lately there had been some pain in the left eye.

*Examination.*—At this visit the vision of the right eye was 5/5, with +1.75 D. sph., that of the left was 5/24, also with +1.75 D. sph. Ophthalmoscopic examination showed quite severe neuroretinitis in the left eye. The right fundus was normal.

*Treatment.*—The patient was put on potassium iodid in moderate doses, and the intraocular inflammation steadily improved until, on March 29, 1898, when the record states that the whitish inflammatory exudates had entirely disappeared, and the vision was 5/5. There was a faint scotoma in the outer part of the visual field. The right eye had remained healthy.

*Course of Disease.*—Feb. 20, 1905. He has had no further eye trouble. The vision of each eye is 5/5, with a slight scotoma in the outer part, near the center of the visual field of the left eye. No fundus lesions could be seen with the ophthalmoscope in either eye, and the left optic disc is of normal color.

The patient's kidney affection has apparently been cured, and his general health is good.

CASE 7.—Neuroretinitis in right eye, very severe, duration eight months, loss of vision, except at periphery of visual field, neuroretinal atrophy.

*Patient.*—Mrs. S. D. Buffalo, N. Y., consulted me on Dec. 18, 1903, complaining that she had not been seeing as well "lately" with her right eye as with her left.

*Examination.*—She is a strong, healthy, hard-working woman, and is the mother of several healthy children, still living. With the right eye she could count fingers at two or three feet, no better with glasses. Vision of the left eye with +2.25 D. sph. was 5/5. The ophthalmoscope showed the right optic disc obscured. The retinal vessels were very tortuous and much engorged, and scattered throughout the retina were many large and small hemorrhages. The fundus of the left eye was entirely normal, and there was no evidence of retinal arteriosclerosis.

The patient had, apparently, a normal heart. The arteries did not seem to be atheromatous.

*Course of Disease.*—The retinal hemorrhages were gradually absorbed in the course of six or eight months, and pronounced optic-nerve and retinal atrophy supervened, leaving a large dense scotoma in the central and inner part of the field of vision, while at its periphery the patient could count fingers, better at the upper and outer parts.

The left eye remains normal, with supernormal vision.

Case 8.—Neuroretinitis in right eye, severe, duration eight months, resulting in loss of vision centrally, but not entirely peripherally; neuroretinal atrophy. Chronic albuminuria, arteriosclerosis.

*Patient.*—W. H., Buffalo, N. Y., aged 65, merchant, had been a patient of mine since March 6, 1899, when he consulted me for change of glasses for presbyopia. He had worn glasses for near work, but thought he needed stronger ones. He had occasional headaches.

Examination at this time showed the vision of each eye to be 5/4, also with +0.25 D. sph. The muscle test with a Maddox rod gave orthophoria. I ordered glasses for near work, R. and L. each, +2.75 D. sph. The ophthalmoscope showed both fundi normal.

*Later Condition.*—Sept. 17, 1901. He continues to have headaches, though he has the general appearance of being in good health. He works hard in his business, mostly at the desk. He denies having any illness, although his professional friends tell me he has Bright's disease. I found the vision and the fundi of his eyes as before—normal. Changed glasses for near work to R. and L. +2.25 D. sph.

*Course of Disease.*—April 16, 1904. He complained that the vision of the right eye had been failing for about two weeks. He had not been well for a long time, and was being treated for "kidney trouble" by Dr. Woehnert of Buffalo. He had had a great deal of headache, sometimes very severe, and there were some albumin and casts in the urine. At this visit the vision of the right eye was 5/60—a little better eccentrically, while that of the left eye was 5/4, nearly all the letters. The ophthalmoscopic examination showed pronounced neuroretinitis in the right eye, the optic disc being abnormally reddened and somewhat obscured, the retina hazy, the retinal vessels tortuous, and to the temporal side and above the optic disc there was a small flame-like retinal hemorrhage; near the macula lutea there were two or three small, whitish exudates. The visual field was concentrically contracted, and there was also a central scotoma.

The fundus of the left eye was perfectly normal in every respect.

*Consultation.*—The patient consulted Dr. William Osler of Baltimore and Drs. Edward Janeway and Herman Knapp of New York, who agreed with Dr. Woehnert as to the diagnosis of albuminuria with general arteriosclerosis.

The neuroretinal inflammation gradually subsided in the course of three or four months and atrophy followed. The vision never improved, but with the atrophy of the optic nerve, became reduced to the counting of fingers at two or three feet, eccentrically. With the subsidence of the inflammation also, all traces of retinal hemorrhages and exudates disappeared. There was not the appearance of albuminuric retinitis at any stage of the neuroretinal disease; neither did the retinal vessels show ophthalmoscopic evidences of arteriosclerosis.

The left eye remained normal, both in vision and in structure, till May 20, 1905. At this time the patient was attacked by an excruciating headache, which lasted three or four days. During this time there was much congestion of the ocular circulation, involving both the choroidal and retinal vessels of the left eye. A small hemorrhage in the left vitreous humor took place, and the left optic disc became reddened and hazy. No other fundus changes could be detected. Vision was reduced to 5/9 on May 27. Under general treatment and rest in a darkened room the fundus cleared up in the course of from three to four weeks, vision was restored to 5/6, and the optic disc and retina regained their normal appearance.

*Termination of Case.*—The patient died on Dec. 8, 1905, from uremia. Immediately before death the right eye was nearly blind from atrophy of the optic nerve, following the neuroretinitis, and the left eye was normal.

*Remarks.*—While the left eye was temporarily involved in an exaggerated hyperemia at one time, I believe the case should be regarded as one of uniocular neuroretinitis, following the typical course and stages of inflammation, with swelling, edema, hemorrhages, exudates and subsequent atrophy.

### UNIOCULAR RETINITIS.

CASE 9.—Retinitis, right eye, severe, duration and result unknown. Evidences of arteriosclerosis.

*Patient.*—Mrs. M. M., Wright's Corners, N. Y., aged 65, consulted me on March 19, 1891.

*History.*—She had been under the treatment of Dr. Kittenger of Lockport, N. Y., for trouble with her eyes. The vision of the right eye had been getting dim for two months and was growing worse. Her health was good and there was no urinary or brain disease. There was, however, evident arteriosclerosis.

*Examination.*—Vision of the right eye was 5/60, and with +1 D. sph. it was 5/36. The ophthalmoscope showed numerous retinal hemorrhages above and to the outside of the macula lutea. The retinal vessels were also congested and abnormally tortuous, and the retina was edematous. No exudates were seen, and the optic disc was normal.

The vision of the left eye was 5/9, and with +1 D. sph. it was 5/5. The fundus of this eye was normal.

*Remarks.*—This woman was referred back to Dr. Kittenger for treatment, and I have not seen her since.

Case 10.—Retinitis in left eye, mild, duration a year and a half; recovery with scotoma upward and inward, vision 5/6. No kidney or other disease, except "very nervous."

*Patient.*—Mrs. B. Van T., Union, N. Y., aged 49, has been "very nervous and poorly" for a long time.

*History.*—She has been an eye patient of Dr. Michael of Binghamton, N. Y., and was referred to me by Dr. Simmons of Susquehanna, Pa.

Her first visit to me was on Sept. 15, 1897. Her eyes had been "weak" for a long time, but on July 7, 1897, she found that the vision of the left eye had become much worse, being most dimmed upward and inward in the visual field. She consulted Dr. Michael, who told her that there were hemorrhages and other changes in the retina of that eye, and asked her to have her family physician, Dr. Simmons, examine her urine. This was done without finding anything abnormal.

*Examination.*—On her first visit to me she said that there had been pain over the left eye, and that she was "weak and nervous." The vision of the right eye was 5/5, also with +0.25 D. sph. That of the left was 5/60, better eccentrically, by turning the eye upward and inward; not improved by glasses.

Under homatropin, vision was the same as above in each eye, and the right fundus was normal. The left optic disc was quite normal in appearance, but the retina was a little edematous, with several whitish exudates below the macula, and a little toward the nasal side, and still farther downward there was quite a large retinal hemorrhage, which seemed to be fading.

*Treatment.*—I referred her to her family physician for treatment, with the suggestion that she be given potassium iodid.

*Course of Disease.*—Oct. 10, 1898. The retinal lesions were less pronounced, and the vision was improved.

May 16, 1899. All exudates and hemorrhages have disappeared in the left eye, and vision eccentrically was 5/6. Right vision and fundus were normal.

March 5, 1906. There had been no recurrence of the retinal disease of the left eye, and both fundi appeared normal. There was no paleness of the left optic disc. Vision in the left eye continued to be 5/6. The scotoma in the left visual field upward and inward remained, although less pronounced.

Her general health was somewhat improved, but she still "had no endurance and tired easily." There was no heart disease, nor was there apparent arteriosclerosis. Urine was normal.

CASE 11.—Retinitis in right eye, mild, duration over one year; recovery, vision 5/7, with small scotoma above, but near the center of the visual field.

*Patient.*—H. B. S., Buffalo, N. Y., aged 26, unmarried, is doing clerical work and examining records in the county clerk's office. He is a young man of good health and habits, and has no evidence of urinary or heart disease.

*Examination.*—He consulted me on Jan. 21, 1899, stating that he had not been seeing as well as usual for the past two or three weeks with his right eye. Vision of this eye was 5/60, not improved by spherical or cylindrical lenses, and objects seemed distorted. The visual field was blurred near the center. Vision of the left eye was 5/6. After dilating the pupils with homatropin the opthalmoscope showed the retina of the right eye edematous, with a whitish exudate of considerable size at the macular region, and very small ones lower down. The optic disc was clear, but considerably reddened. The fundus of the left eye was normal.

*Treatment.*—The patient was given moderate doses of potassium iodid.

*Course of Disease.*—On January 23, vision of right eye was 5/24; on February 11, it was 5/15; on March 27, it was 5/12. On the latter date an ophthalmoscopic examination of this eye was again made under the influence of a mydriatic, when it was found that the exudate at the macula was smaller and had become somewhat pigmented. There were also a few small pigmented dots around it. No faded choroidal areas.

Aug. 2, 1900: Vision of right eye was 5/9, and the retinal exudates were scarcely observable. Objects still appeared more or less distorted. The left eye continued normal.

On March 20, 1903, vision of right eye was worse—5/15; left was 5/5 +. The right eye under mydriatic showed the lesion around the macula to be diminished, but there was another whitish exudate of smaller size below and to the nasal side of the macula. The patient was again ordered to take five-grain doses of potassium iodid three times a day.

April 24, 1903: The eye was better. From this time the vision of this eye continued to be about 5/12, but the retinal exudates were gradually dispersed till on March 2, 1906, none could be found. On the latter date the patient was re-examined under homatropin for glasses, when the right eye took — 0.50 D. sph. ○ + 1.75 D. cyl. ax. 90, giving vision 5/7; left eye — 0.25 D. sph. ○ + 1.50 D. cyl. ax. 90, vision 5/5 +. There was still slight distortion of objects as seen with the right eye, and small scotomata above, but near the center of the field of vision.

Case 12.—Retinitis in right eye, pronounced, duration over six months; result unknown.

*Patient.*—F. R. P., aged 53, attorney, married, came to me on April 8, 1904, complaining that the vision of his right eye had been more or less impaired for two years.

*Examination.*—At this time vision was 5/15, not improved by glasses, and objects looked distorted. The vision of the left eye after correcting refractive error with — 0.75 D. cyl. ax. 165, was 5/4. After dilating the pupils the ophthalmoscopic examination showed, in the right eye, several yellowish-white exudates around the macula, and a fading retinal hemorrhage above it and inward. The retinal veins above the macular region were unusually tortuous. The optic disc was normal. The record notes say: "The whole appearance is suggestive of albuminuric retinitis." The fundus of the left eye was perfectly normal. The urine was afterward examined several times by an expert, and never showed any evidence of kidney disease. The patient had no arteriosclerosis, and seemed in good health every way. He was ordered to take potassium iodid.

*Course of Disease.*—The patient was seen again on Nov. 23, 1904, but his eye was no better. Vision was 5/30. I have not seen him since.

Case 13.—Retinitis in right eye, mild, duration six months or more; recovery, vision 5/7, slowly. Occasional albuminuria, but chronic nephritis not conclusive.

*Patient.*—H. A. W., Buffalo, N. Y., a patient of Dr. Earl P. Lothrop, consulted me on Sept. 28, 1904, for a dimness of vision of his right eye, which had been troubling him for several days. He was a man 56 years old, tall and stout and had been "poorly" for several months. He said that he had had "kidney trouble" for a long time, and that at times there had been a little albumin in his urine.

*Examination.*—He was wearing glasses, — R. + 1.25 D. sph. and L. + 0.75 D. sph., with + 2.50 D. sph. added in bifocals. With these distance glasses, vision was R. 5/30, L. 5/6. Right vision was not improved by other lenses, but the left with + 0.50 D. sph. ○ + 0.75 D. cyl. ax. 150, vision = 5/5. Both pupils were of the same size, and responded equally to light. There was a marked central scotomata in the visual field of the right eye. Ophthalmoscopically, the right optic disc was slightly hazy, and there were several retinal hemorrhages and three yellowish-white exudates discernible at the macular region.

The fundus of the left eye was normal in every respect. I may add here that both eyes were under the influence of a mydriatic (homatropin) while making the ophthalmoscopic examination.

*Course of Disease.*—Oct. 1, 1904. Vision of right eye was 5/9, with + 1.25 D. sph. lens.

Jan. 16, 1905: Vision of the right eye was 5/7, with + 1.50 D. sph. The retinal hemorrhages had disappeared, but there remained a single, small whitish exudate near the macula lutea. The left eye continued normal.

The patient was last seen on Dec. 20, 1905, when the vision was found to be 5/7, with + 1.50 D. sph., right eye, and 5/5 (half), with + 0.50 D. sph. ○ + 1.50 D. cyl. ax. 160, left eye. The pupils being dilated with homatropin, the right eye, as well as the left, showed no retinal or optic nerve abnormalities.

CASE 14.—Retinitis in right eye, severe. Seen but once.

*Remarks.*—This case is one that I take the liberty of recording, although my information in regard to it is quite scant. It was that of a man about 50 years of age, who was presented, in 1904, to the Buffalo Ophthalmological Club by one of its members. The patient had been losing sight of his right eye for several weeks without pain. The vision of the left eye, he said, was good. The ophthalmoscope showed a typical retinitis with numerous hemorrhages scattered throughout the retina and tortuous vessels in the right eye. The fundus of the left eye was normal.

*Patient.*—The patient was a laborer and was a strong, healthy-looking man. He had no organic disease of the heart or any apparent symptoms of arteriosclerosis or of brain or spinal cord disease.

CASE 15.—Retinitis in left eye, severe, duration over six months, passing into atrophy; vision perception of light. Poor health, mostly "digestive troubles," arteriosclerosis.

*Patient.*—Mrs. J. M., Orchard Park, N. Y., aged 63, was referred to me by Dr. Hunt on Sept. 30, 1905.

*History.*—She had been in poor health for the past two or three years, mostly with "digestive troubles" and general weakness. She had no organic disease of the heart, but radial arteries were "hard."

*Examination.*—The vision of the left eye had been failing for the past two or three months, and was now a little more than perception of light. The right eye had vision of 5/6, with — 1 D. sph. ○ + 1.75 D. cyl. ax. 90. The ophthalmoscope showed severe inflammation of the retina of the left eye, with distended, tortuous retinal vessels, and many "flame-like" hemorrhages of various sizes scattered throughout the retina.

The fundus of the right eye was normal. Atrophy of the optic nerve was taking place later.

Case 16.—Retinitis in left eye, mild; still in progress, and under observation.

*Patient.*—G. P., Buffalo, N. Y., photographer, aged 68.

*History.*—He has been in fairly good health for years. He has no organic disease of the heart, kidneys or brain. There was some arteriosclerosis. He has never had syphilis.

*Examination.*—Feb. 10, 1906. Glasses for near work do not seem comfortable. Examination with the ophthalmoscope showed both fundi normal. V. R. 5/6, and with —0.37 D. cyl. ax. 100, it was 5/5. V. L. 5/9, and with —0.50 D. sph. $\overset{\frown}{\smile}$ + 0.75 D. cyl. ax. 15, it was 5/5, half. Adding + 2.75 D. sph. to these gave distinct vision in each eye for Jaeger 1 at 13 inches. These I ordered for near work.

*Course of Disease.*—On February 20 he returned to me, saying that for the past three days the vision of the left eye had been quite dim, and horizontal lines seemed to be "broken and tipped down to the right." He had no trouble with the right eye. On examination the vision of the left eye was reduced to 5/30, and the ophthalmoscope showed several minute retinal hemorrhages at the macula, and slight retinal edema. The optic disc was normal. The right fundus was normal.

*Treatment.*—Potassium iodid was prescribed in moderate doses, to be taken three times a day.

*Course of Disease.*—March 6: Vision of the left eye was better, and there was less distortion of lines and letters.

April 4: Vision of left eye was worse, being less than 5/60. Objects seemed more distorted, and there was a central scotoma of considerable size. The ophthalmoscope showed an enlarged retinal hemorrhage at the macular region. He had an idiosyncrasy against potassium iodid, but I urged him to take all he could.

Patient is still under treatment.

Case 17.—Retinitis in right eye, quite severe; still under observation; valvular disease of heart, has had symptoms of cerebral hemorrhage, no kidney disease.

*Patient.*—V. M. H., Buffalo, N. Y., salesman, aged 58, married; on the advice of Dr. DeWitt C. Green, consulted me on March 20, 1906.

*History.*—He complained that for the past few days he had not been seeing well with his right eye, which had always been his "good eye," the other having had poor vision from childhood, being astigmatic in considerable degree. The patient had not been in best of health, and since the spring of 1904, when he seemed to lose control of the muscles of his lower extremities. On Sept. 20, 1904, he was accidentally tripped by a dog and fell to the ground, striking on his right elbow, but not on his head. The fall, however, caused much muscular incoordination and "confusion of mind," which lasted for several months. After this fall he was also troubled for four months with "half vision," but he does not remember on which side. There has been some valvular disease of the heart for at least two years, but no kidney disease. At present the patient has occasional dizzy spells and pain in his head, not definitely located.

*Examination.*—He is now wearing glasses which seem to correct his refractive error properly, R. + 1.25 D. sph. and L. + 2.75 D. cyl. ax. 125 for distance, with + 2.25 D. sph. added for near. With these the distance vision of the right eye, which had heretofore been 5/5, was 5/15; that of the left eye 5/20, which was as good as it has ever been. On dilating the pupils the ophthalmoscope showed a pronounced retinitis of the right eye, localized above and to the temporal side of the optic disc. There were four or five retinal exudates of considerable size near each other, and a few smaller ones adjoining. There was one large retinal hemorrhage between the exudates and the optic disc, and numerous smaller ones surrounding the exudates. The optic disc appeared perfectly normal. The visual field was not contracted, but there was a scotoma near the center of the field, downward and outward, and objects looked distorted. The fundus of the left eye was perfectly normal. The vision of this eye was congenitally amblyopic.

The patient is still under treatment with potassium iodid.

CASE 18.—Retinitis (macular) in right eye, single exudate at macula, duration three months to date, central scotoma, vision 5/60; still under treatment.

*History.*—On April 7, 1906 (just as I am concluding this paper), Mrs. M. A. S., aged 60, consulted me for impairment of vision of right eye, which had troubled her for the past three months, but which for the past two weeks had been worse. She was wearing glasses, R. and L. + 1 D. sph., with which she says her vision had been perfect in each eye. With the right eye she had, during the period named, seen a "black spot" in the central part of the visual field, round in shape, and at fifteen feet about "eighteen inches in diameter." The patient's general health was good in every respect, and there has been no history of albuminuria.

*Examination.*—Vision was 5/60, a little better eccentrically in any direction. Vision of the left eye was "clear" and with + 1 D. sph. was 5/6, but with + 1.50 D. sph. it was 5/5. There was no pupillary disturbance in either eye, and in both eyes tension and all external appearances were normal. After dilating the pupil there was seen with the ophthalmoscope a small, whitish, retinal exudate at the macula lutea of the right eye, but in every other respect this fundus was entirely normal. There was no pigmentary change, no retinal hemorrhage, and the retinal vesels and optic disc appeared normal. Nothing abnormal could be found in the left eye.

*Remarks.*—I am disposed to regard this case as one of

**"macular" retinitis, if I may be allowed to use the term, the minute exudate being the result of an inflammatory process as real as though it were more extended and attended by hemorrhages, other exudates and vascular changes. These changes may take place later in the progress of the case, which I shall watch with interest.**

**At present the condition is uniocular, and I assume it will remain so after the three months which have now elapsed.**

These observations, although purely clinical, and also more or less imperfect, serve my purpose of showing that, at least so far as my own experience goes, uniocular retinal and optic-nerve inflammations are not as rare as ophthalmologic literature would lead us to believe. If my case-records were minutely searched I am sure that several other cases would be found. If I were to suggest the number of these cases proportionate to the number of eye patients of all kinds seen it would be about 1 to 1,000.

A summary of these cases shows that the optic nerve was inflamed in four of them, in three of which it was intraocular, and in one retroocular. Of the four cases three were females and one male, with ages varying from sixteen to forty-three years, and all were apparently in good health. The right optic nerve was affected in two cases and the left in two. Recovery followed in each, with normal, or nearly normal, optic disc, and normal, or nearly normal, vision.

In four cases the inflammation involved both the optic nerve and retina, two being females and two males, of ages varying from twenty-four to sixty-seven years, only one being under sixty-one. In two the inflammation was in the right eye and in two in the left. One patient's general health was good, one had calculi and inflammation of the right kidney, one had questionable general arteriosclerosis together with chronic albuminuria. The vision of the affected eye was practically lost by atrophy in three cases. It was regained and became nearly normal in one.

In ten cases the inflammation was apparently limited to the retina. It varied greatly in intensity. Four of these patients were males and six were females. The right eye was affected in seven, the left eye in three. Three cases, which were mild, terminated in recovery without leaving perceptible lesions and with vision nearly normal. In one the vision of the affected eye was lost, while in the other six the result is either unknown or the disease is still in progress. As regards the general condition, it was noted to be healthy in six. In three there was some arteriosclerosis, one of these patients having also occasional albuminuria. In one case there had been symptoms of slight cerebral hemorrhage together with valvular heart disease.

Thus, it will be seen that it is difficult to place any etiologic relation between these inflammations and any other specific disease. One-sided nephritis was present in one case; more or less arteriosclerosis existed in five patients, two of whom also had albuminuria; in one of these it was occasional and in one chronic; valvular disease of the heart together with a previous cerebral hemorrhage was found in one, while the rest of the eighteen were classed as healthy and without cerebral, vascular or kidney disease.

I desire to add in conclusion that in quite a large experience of a quarter of a century in ophthalmology I have never seen a case of optic neuritis that was not uniocular, except when there was syphilis or brain tumor. I have never seen a case of neuroretinitis or of retinitis that was not uniocular, except when there was double orbital cellulitis, Bright's disease, diabetes mellitus or syphilis, and then it was typical of these diseases, and even in two albuminuric cases and one of nephritic inflammation, the inflammation was uniocular. I do not insist that this must have been the experience of others.

My treatment has almost invariably been the administration of potassium iodid. I believe that it has proved beneficial in some of the cases. In others it seemed to be of no benefit.

212 Franklin Street.

CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# RETROBULBAR OPTIC NEURITIS FOLLOWING CHILD BIRTH.*

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*Case 1.—A case of recurrent retrobulbar optic neuritis of one eye following successive childbirths, and ending in atrophy of optic nerve, with whitening of part of the eyelashes and eyebrow of same side.*

*History.*—The patient was a strong healthy woman, about 25 years of age, at the time of her third pregnancy when she first came under my observation. I learned from her at this time that her first pregnancy occurred about four years before the third, and the second more than two years before the third. Her eyes have always been good, she has never had an inflammation of the same, and the vision of both was excellent up to the time of her first pregnancy. Shortly after her first confinement she had an attack of transitory blindness in the right eye, from which she recovered completely. She had another temporary loss of vision in the right eye soon after she gave birth to her second child, but this also passed away in a few weeks, and after that, up to her third confinement, the vision of this right eye was very good. I saw her for the first time five weeks after her third confinement. She then complained of pain and a queer feeling in the right eye.

October 1. Third pregnancy. She is nursing the child. Is in good health.

*Examination.*—The right eye is entirely normal in appearance and the movements of the globe unimpeded in any direction. The ophthalmoscope showed perfectly clear media. The optic papilla was of normal appearance, but the retina around disc and the region of the macula was somewhat less transparent there than elsewhere. She had an absolute central scotoma. The periphery of visual field was not contracted. She had no disease of heart. Urine contained neither albumen nor sugar. Ordered six leeches to right temple. Also potass. iod., 5 grs., three times daily. On the following day the opacity of the retina around disc and in macular region was less, and she was able to recognize outlines of large objects. Her vision was not tested closely as she was in bed and her eye was sensitive to light.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

*Clinical Course.*—October 4. Supraorbital neuralgia over right eye. Patient can count fingers at five feet. The opacity of the retina has again apparently increased.

October 6. To-day V. 3/60. The opacity of the retina is markedly increased, especially around disc. She has been taking quinin for the supraorbital neuralgia.

October 8. I noticed to-day for the first time that the eyelashes and hair of brow situated in line with supraorbital notch are white, while the rest are of dark color.

October 13. V. 5/9. Opacity of the retina has disappeared, but the disc is now paler than on previous examinations and the retinal arteries are somewhat narrower.

November 1. V. 5/8. Disc very pale, arteries small.

During the following year patient was seen every month. V. 5/8, with V. F. intact at end of year.

Fourth pregnancy two years after third.

*Recurrence.*—August 27 I was called to see patient again. Learned that she had been confined of a healthy child two weeks previously. She was in good health and was nursing the baby. The urine was free from albumin and sugar. I learned from her that her vision, which had been very good in the right eye up to a few weeks before her confinement, had suddenly become greatly impaired several times in the two weeks preceding the confinement, but had returned after a day or two. Last night, while sleepless in bed, after more or less headache during the last forty-eight hours, noticed that she was totally blind in the right eye. She is confident that she could see very well with this eye yesterday, and that the blindness came on suddenly. She has now pain in and above the right eye. The attending physician had dropped a solution of cocain in this eye a few hours before I examined the eye on this occasion. Examination showed normal exterior of the right eye. The pupil somewhat dilated from cocain. The media were perfectly clear. The disc was very pale and its outlines quite indistinct. The adjoining retina was cloudy; the retinal veins were smaller than those of the left eye, and the arteries markedly so. Has perception of light only, but in all parts of field. Ordered six leeches to left temple and internally iodid of potassium in gradually increasing doses.

September 22. The only noticeable change in appearance of fundus is a small extravasation of blood of macula, and between this and outer periphery there are several others, of round form and larger size; vision not improved.

October 3. To-day she can count fingers at a foot in outer part of field. The hemorrhages are disappearing. Otherwise as before.

December 20. Marked atrophy of optic papilla. V. 0. This eye diverges.

*Later History.*—Since then this eye has become totally blind. The hairs in the brow and the eyelashes in a line with the supraorbital notch have remained white and are so to-day, ten years after the change was first noticed. The patient has not been pregnant since her fourth confinement. Two years after last confinement she had photopsies in the left eye, which up to this time had never given her any trouble, but they passed away after a few days and have not returned since. A few months later she had a slight attack of catarrhal conjunctivitis in the left eye, for which her family physician instilled some drops which caused much injection of globe, pains and flashes of light, followed by marked dimness of vision. I saw her on the following day. The eye was still injected, V. 5/5, V. F. intact for form and colors, in daylight and in dimly lighted room.

Ten years later the examination showed the left eye to be entirely normal

No one will doubt, I think, that the pregnancies or the childbirths were responsible for the development of the eye disease. To me it seems most probable that the pregnancies caused a disturbance in the vascular supply, a congestion at or near the apex of the orbit, and that this produced pressure on the optic nerve and its sheaths and also on the branches of the ophthalmic branch of the fifth nerve. Others who have observed somewhat similar cases following confinement and during lactation have attributed the optic nerve disease to an auto-intoxication. A full account of the views held by different writers as to the causes of this affection, as well as summary of these cases previously published, will be found in a paper by Dr. George S. Derby,[1] entitled "Optic Neuritis During Lactation, Including a Reference to Other Ocular Conditions Observed in This Period."

As regards the whitening of some of the eyelashes and some of the hair of the brow, this has been observed in some severe cases of iridocyclitis mostly of the sympathetic form. So far as I can ascertain, the case here reported is the first one in which this has occurred in connection with retrobulbar optic neuritis. Only a part of the lashes and of the hair of the brow were affected, namely, those in line with the course of the supraorbital nerve. The absence of the pigment in the hair was undoubtedly due to a change in the hair papilla whereby the supply of pigment to the hairshaft is interrupted. The hairs without pigment seem also to be less thick than the colored ones near them. Although I saw the patient daily, I did not observe any change in the color of the lashes till after a severe attack of supraorbital neuralgia. I am unable to say that the change in the color of the hair occurred over night, but I am certain that it took place within a few days. The lashes at the place described and the hairs in brow are still white, ten years after the change was first noticed. The lashes of the lower lid of the same eye and the hairs of the brow of the other side are all still of a brown color. An interesting paper on the premature whitening of the eyelashes by Dr. Alfred Vogel will be found together with the literature of this subject in *Klinische Monatsblätter für Augenheilkunde,* Februar und März, 1906, p. 228.

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[1] Archives of Ophthalmology, vol. xxxiv, p. 9.

*Case 2.—A case of retrobulbar optic neuritis of one eye, following childbirth. Recovery of vision.*

*History.*—Mrs. W. M. D., 35 years of age, was delivered of first child on July 1, 1899, and had convulsions, but no albuminuria, according to her physician. Shortly after confinement she noticed a blur before right eye. This has gradually increased to such an extent that she can only see large objects with this eye at present. The child died a few days after birth.

*Examination.*—When first seen by me, Feb. 12, 1900, I found that the vision of right eye was less than 6/60. The left eye had S. 6/6. Both eyes were entirely normal in appearance, externally, and the mobility of both eyes was unimpaired. Ophthalmoscopic examination revealed entirely normal conditions in the left eye, and in the right eye a marked paleness of disc was the only abnormality discovered. Examination of the field of vision of left eye showed contraction of about 20° all around for form and a corresponding contraction for colors. The V. F. of right eye was contracted to a somewhat greater extent, blue and red are recognized only close to point of fixation, and green is not recognized at all. The patient, a large, healthy-looking woman, is now in good health. Urine contains neither sugar nor albumin. I prescribed iodid of potassium in 10-grain doses three times daily.

*Clinical Course.*—During the following months there was a steady improvement and on March 28 (six weeks after her first visit to me) vision of left eye was S. 6/6. The V. F. was of normal dimensions for form and for blue, but was contracted for red and green. A month later the V. F. was only slightly contracted for green, otherwise normal. The ophthalmoscopic examination at times showed a very grayish disc, otherwise normal condition. The right eye was entirely normal, S. 6/6, V. F. intact for form and color.

When last seen by me, March 1, 1903, nearly three years after her first visit to me, I found the sight of each eye to be S. 6/5, the V. F. intact for form and colors. The ophthalmoscopic examination showed marked atrophy of papilla of left eye, the retinal vessels were of about normal caliber. The right eye was normal in every respect.

She has not been pregnant since she gave birth to her first child.

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1906.

# THE BACTERIOLOGY OF THE EYELIDS.*

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BOSTON.

In considering the bacteriology of the eyelids it is important to remember that we are dealing with structures which, from their anatomic peculiarities and from their situation, are subject to a large number of pathologic processes.

We have first a covering of skin exceedingly thin in texture and bound down but loosely to an underlying tissue which is free from fat, thus presenting features which modify to a certain extent the course and picture of certain affections when they occur in this region, as seen, for instance, in the marked swelling which follows a trivial infection. Secondly, we have the ciliary border, covered with a modified skin, with its hair follicles, sebaceous glands, sweat glands and large vascular supply. Thirdly, the large meibomian glands enclosed in a thick fibrous envelope, the tarsus.

The situation of the lids is rich in its pathologic possibilities, no bar is offered to the direct extension of disease from the cheeks, forehead and temporal regions, the tear passages offer an open route from the nose; internally the conjunctiva and cornea are in close contact while the bony structures of the orbit and the accessory sinuses of the nose are but little removed. In the lids, as well as in all other regions where the skin and its appendages are present, the ordinary pyogenic cocci occupy the center of the stage as the primary cause of infections or as secondary invaders in the lesions of other processes.

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## FURUNCLE.

Pasteur's observations on the causation of furuncle by virulent staphylococci have been confirmed by many observers. This affection is not very common on the lids and when present is most often seen in the region of the eyebrow. When it reaches the lid border it receives the name of hordeolum. Furuncle originates from the infection of a hair follicle, sebaceous gland or possibly a sweat gland, by a pus-producing organism, usually the staphylococcus aureus. Various disorders of the system and of the skin may be predisposing factors.

## ERYSIPELAS.

This process represents an infection of the skin with the streptococcus, as was established by Fehleisen. A lesion is considered indispensable, but can not always be demonstrated. The face is the seat of election and infection may take place in the nose or mouth, (for the streptococcus is not infrequently present in the upper air passages) or from a pre-existing process, such as a dacryocystitis or a hordeolum.

Erysipelas of the lids is most often secondary to facial erysipelas. Less frequently it is primary and then seldom remains limited, but invades neighboring parts. Both lids are infected as a rule; there is a very marked degree of swelling, which may close the eye for a number of days, the skin is tense, red and shiny, and, owing to its thinness, infection of the subcutaneous tissue is more likely to take place in this region than in others. Abscess formation is by no means rare, nor is gangrene; occasionally there is an extension of the process to the eyeball or to the orbit with destruction of the optic nerve by pressure, and finally there may be an involvement of the meninges and cerebral sinuses with a fatal outcome. However mild the process, a certain amount of conjunctival reaction is observed.

Occasionally erysipelas of the lids is seen in a low-grade form of long duration, with frequent recurrences, and this may lead to a permanent alteration in the structure of the lid, and to the formation of new spongy tissue. Such has been the origin of the cases reported as elephantiasis of the lid by Liebrecht,[2] Anderson Smith,[3] Pedraglia[4] and Deutschmann,[4] Farreras,[5] Anderson Critchett,[6] Rombolotti[7] and others. Von Michel[8] has seen impetiginous eczema, supervening on erysipelas of the lids, and obtained the streptococcus from the lesions.

## LID ABSCESS AND PHLEGMON.

Abscess formation is due in most cases to infection with the ordinary pyogenic cocci. Ogston examined the pus from 100 cases and found cocci in all the acute ones. Steinhaus analysed 330 cases of different observers and found in 66 per cent. staphylococci, in 20 per cent. streptococci and a mixture of the two forms in 9 per cent. Other organisms are rare. To the staphylococcus is commonly due the acute localized processes terminating in pus formation, while the streptococcus is more often concerned in the production of spreading inflammation such as phlegmonous cellulitis.

The bacteriology of abscesses and phlegmonous inflammations of the lids differs not at all from that in other localities. This is well illustrated in a small series of cases reported by Gallenga,[9] who observed, during the summer of 1904, and chiefly among poor people afflicted with various dermatoses, a large number of abscesses occurring on the lids and also on other parts of the body. In his series of twelve bacteriologic examinations he obtained the staphylococcus ten times and the streptococcus twice.

Among the etiologic factors leading to lid abscess, an infected wound is without doubt the most frequent; I have already spoken of furuncle and erysipelas. Carron de Villards[10] describes severe infections from the sting or bite of a large variety of insects and scorpions and in this connection Zia[11] reports the case of a child who developed a phlegmonous swelling of the lid due, the parents thought, to the bite of a fly. Under acute symptoms an abscess formed, accompanied by gangrene of the conjunctiva, extension to the orbit, meningitis, and death. An examination disclosed the *Staphylococcus aureus* in pure culture. Elschnig[12] and others mention as among the causes of lid phlegmon, extension of infection from neighboring parts as from an acute dacryocystitis, from orbital phlegmon, panophthalmitis with suppuration of the peribulbar tissue, periostitis and necrosis of the bony walls of the orbit and empyema of the accessory nasal sinuses. Fage[13] has seen orbital and palpebral abscesses from suppuration of the orbital process of the superior maxilla and Galezowski[14] has seen many similar cases. Ziem[15] reports an abscess in the lower lid of a child, extending from an antrum infected by a carious tooth socket. Occasionally infection of the lid takes place from an acute conjunctivitis. Thus Fruginelli[16] reports an abscess following a pseudomembranous conjunctivitis from the membrane and pus of which the pneumococcus was cultivated. Fuchs[17] describes a severe lid swelling and gangrene of all four lids of a child, complicating gonorrheal conjunctivitis. Berger[18] and Elschnig[12] report lid abscesses following the same cause and both liken the process to the formation of a peri-urethral abscess in gonorrheal urethritis from the penetration of the organisms into the peri-urethral tissue. In opposition to this view, however, it must be urged that the gonococcus has never been found in a lid abscess, that the drainage of gonorrheaal pus is far better cared for in the eye than in the urethra and the infection in these cases was very probably due to some ordinary coccus in a tissue of low vitality. Lid abscesses are not uncommonly observed in children during the first years of life to all appearances of spontaneous origin, but probably due to some unnoticed lesion or possibly to metastasis from some masked infection and resembling the "metastatic" affections of the eyeball of uncertain origin which are occasionally seen.

In connection with a number of general infectious diseases like the exanthemata, lid infections may occur. Such cases have been reported by Bock,[19] Landolt,[20] Wicherkiewicz,[21] Hosch[22] and others in influenza. In some cases the lid infections subside without suppuration, while in others they progress to abscess formation. Pfeiffer's bacillus has never been demonstrated as the cause. As early as 1794 Himly[23] saw phlegmon of the lids and gangrene in severe cases of typhoid and apparently no one has ever seen it since, though gangrene is not a rare sequel of typhoid and many parts of the body have been affected (Keen[24]). Jackson[25] describes lid abscess after scarlet fever in a case which also developed bronchopneumonia and an infection in the tibia. Landesberg[26] and others have seen it in smallpox. Elschnig[12] reports a lid phlegmon in a case of general infection and conversely Fraenkel[27] has observed a pyemia proceeding from this cause. Further observations will be found under their special headings, as gangrene, anthrax, actinomycosis, etc.

## GANGRENE.

Gangrene of the lids, though not of common occurrence, can hardly be classed as rare. There is a large literature on the subject, which can only in part be referred to here. Further references may be found in the articles of Roemer,[28] Pes[29] and Elschnig.[12] As will be seen, this process may be due to a number of different micro-organisms, though in but a small number of the cases has a bacteriologic examination been carried out; it may follow many diseased conditions of the body, it may occur in tissues from which the vitality has been sapped by some local cause.

Several factors are active in the production of a gangrenous process. First, micro-organisms, which are doubtless present and active at some stage of the process, and which may have the special qualities necessary to produce gangrene and necrosis of the tissues involved, as in the case of the anthrax bacillus; second, the task of the germ may be made easier by the diminished vitality of the tissue, be it by pressure caused by a marked swelling, by anemia due to the excessive application of cold, by destructive wounds or burns or by a weakened condition of the system as in the scrofulous and anemic children, general infections and diabetes. It is probably only in the gangrene of purely vascular origin, as in Raynaud's disease, that bacteria are unimportant. The anthrax bacillus in the past has probably been the most frequent cause of gangrene of the lids. These cases I exclude from consideration at present. Of the other micro-organisms the streptococcus is most often found, and a history of some form of trauma is usually given.

Of four of the cases collected by Pes, in which a bacteriologic examination was given, the streptococcus appeared three times and the staphylococcus once. In the first of Pes'[29] cases infection was produced by an insect bite, there was a severe inflammation involving the whole side of the face and the neighboring glands; and the skin of the lids, with the exception of the ciliary margins, became gangrenous. Gangrene from insect bites was also observed in the tropics by Carron de Villards.[10] Other very trivial injuries will lead to gangrene. In Pes'[29] second case the process started from a scratch caused by a hen's claw.

In Friedenwald's[30] case the original injury was a scratch, in Valude's[31] case a gangrenous phlegmon of the lids and orbit started from a small wound of the lid. In Giulini's[32] case the starting point was from a lesion of impetiginous eczema. Bacilli and cocci were found. Gangrene due to the excessive use of ice has been reported by Plauth.[33]

Gangrene following erysipelas has been observed several times and according to Weber[34] there are three forms, the first representing an essential erysipelatous gangrene of the skin in which small areas die from stasis and slough off; the second, a penetration of the streptococci into the deeper tissues leading to a complication of the skin infection by a cellulitis; the third, a slow, recurring form of long duration, which leads often to multiple abscesses, lowers the vitality of the skin and finally produces gangrene. Joss,[35] R. H. Derby[36] and Mitvalsky[37] have recorded cases of gangrene of the lids following erysipelas, in the latter's the streptococcus was cultivated.

Steffens[38] recovered the diphtheria bacillus from a gangrenous phlegmon of the lids, as did also Mori[39] and Yamamoto[39] and there are several other observations (Vix,[40] Randall,[41] Schillinger[42]) where from the clinical course and microscope alone (?) the diagnosis was made. I would like to emphasize here the necessity of animal inoculation and the recovery of the germ in the exact diagnosis of this disease. At the Massachusetts Eye and Ear Infirmary, among over 20,000 new patients annually, diphtheria of the ocular structures is a very rare disease. In blennorrhea neonatorum Fuchs[47] has seen all four lids become gangrenous; Knies[43] has seen a similar process in measles. Castresana[44] and Goiccechea[44] have also seen gangrene of the four lids (erysipelas).

Gangrene of the lids may also be caused by extension from neighboring inflammations. In Falko's[45] case, an extensive suppuration of the frontal sinus led to thrombosis of the superior orbital veins and cavernous sinus, gangrene of the lids and eyeball, meningitis and death.

In connection with general diseases, gangrene of the lids may result from typhoid and influenza, which have been mentioned in speaking of lid abscess. In scarlet fever it has been observed by St. Martin,[46] Jackson[25] and Kolle.[47] In measles, by Fieuzal[43] in three cases, by St. Martin[49] in one, and by Knies[43] in one. In 270 cases of smallpox Landesberg[50] observed phlegmon of the lids and gangrene in three. In varicella, Roemer[28] gives the only instance and also a complete bacteriologic examination which showed the streptococcus and the *Bacillus proteus vulgaris,* the latter probably a contamination. Possibly this case may be classed under the rare disease known as *Dermatitis gangrenosum infantum* which occurs most frequently after varicella. In whooping cough there is an observation by Morax,[51] who obtained the streptococcus by culture. There are a number of observations on lid phlegmon and gangrene in general septic conditions. In Mitvalsky's[37] case there was a general septicemia arising from a suppurative process in the uterus and tubes. The streptococcus was found. In Joss'[35] case there was erysipelas and gangrene following a delayed delivery. Here also was the streptococcus (microscope). In diabetes, Lagrange has seen gangrene of the lids. Instances of gangrene of the lids of apparently spontaneous origin appear in the literature from time to time. Hilbert[52] in 1882, reported two such cases but in all probability they were due to infection (Roemer). Roemer[28] also disagrees with Kipp's[53] diagnosis of a gangrene due to a trophic neurosis produced by alcohol and regards infection as probable. Roger and Weil[54] report a case of gangrene of apparently spontaneous origin and benign course from which staphylococci were cultivated. Another observation is that of Marlow,[55] under the title of "Noma," which is interesting, as it suggests the question as to whether or not these apparently spontaneous cases in poorly nourished children have any connection with the true noma. Buday[56] in his recent article concludes that noma belongs to the so-called infectious gangrene, due to a variety of mouth bacteria, but most often to a symbiosis of a spirillum and the *Bacillus fusiformis.* The bacteriologic and histologic features are characteristic.

From the foregoing observations it seems probable that gangrene of the lids is due always to infection and that in the majority of cases the infecting agent can be demonstrated. Anthrax excluded, we have the streptococcus as the most frequent organism while the staphylococcus and the diptheria bacillus occasionally occur. Doubtless in the future many other bacteria will be described.

## ANTHRAX.

It seems probable that the eyelid is not an uncommon seat of the anthrax pustule, though for various reasons there are comparatively few cases in which the observations were confirmed by finding the bacillus; according to Pes[29] seven or eight.

In the first place the disease flourished before the importance of bacteriology was understood and the sanitary science of the present day has placed anthrax among the rare affections in civilized countries. A majority of the observations come from the Latin countries. They are often inaccessible in the original to the foreigner and but briefly abstracted in the reviews and the difference in nomenclature is considerable. Thus we have the following titles: *"Oedème malin," "Oedème malin ou charbonneux," "Pustule malin," "Charbon," "Anthrax,"* and the like. Charbon refers more especially to the anthrax lesion, while anthrax represents the common carbuncle. From what we have already seen of the severity of lid infections, it seems probable that some of these cases were not true anthrax. Two undoubted cases were reported by Elschnig[12] in 1893; both patients recovered and the bacteriologic examination showed anthrax bacilli of low virulence. Rouxau[57] in 1886 reported a benign case. On the other hand, Dujardin[58] saw three-fourths of the upper lid become gangrenous in sixteen hours and Dubujadoux[64] reported two cases which came to autopsy. Among other observations are those of Debrou,[59] Pes.[29] Chevalier,[60] Deprés,[61] Socar[62] and Mauzevin.[63] In 1007 cases collected by W. Koch,[65] the eyelids were affected ten times. As is well known, the disease is usually transferred to man from diseased animals, either directly or indirectly, as in handling hides.

Contagion from man to man is rare, but occasionally does occur, as is shown in Elschnig's[12] case, where a woman contracted the disease from her husband. As a rule the organisms are carried to the eyelids by the hand and for inoculation some lesion in the continuity of the skin is necessary. In regions covered by thick skin it takes some time for the bacteria to reach the subcutaneous tissues; in the lids proper, however, this occurs rapidly and severe symptoms may set in with great rapidity. The organisms while in the skin form a thick network beneath the rete mucosum and cultures are easily secured. The incubation period is from one to three days, rarely longer.

The infection on the lids shows itself usually in the form of the anthrax pustule more rarely as the edematous form. The first sign is the formation of a papule, later a vesicle forms which contains a brownish fluid. If this be not opened, it dries up and forms a scab. The surrounding skin is somewhat reddened, swollen and indurated. The affected area enlarges, gets darker in color and a black eschar is formed which may involve a large part of the skin of the lid extending from the orbital margin down to the ciliary border, which usually remains intact. Not infrequently, a circle of vesicles is formed around the eschar. The neighboring glands are generally involved. In this form severe complications are not uncommon.

The other variety of anthrax is characterized by edema and a more frequent general involvement. In its later course it resembles closely the carbuncular form, though first characterized by a diffuse, white edematous swelling affecting both lids and often involving the face to an enormous extent. Swelling of the glands and sometimes septicemia and death follow. In comparison to the anthrax of other parts of the body, that of the lids is relatively benign.

### SQUAMOUS BLEPHARITIS.

The nature of this affection, which is also known as simple blepharitis or marginal blepharitis, is in doubt and will probably remain so for some time to come. Whether or not it is primarily due to bacterial infection is uncertain to say the least. Some authors regard it as an eczema, while others (Fuchs[17]) believe that it corresponds to seborrhea sicca, and the question of bacterial origin of both those diseases is still unsettled. Weeks[66] believes that there is an eczema of the lid border which resembles blepharitis marginalis and is due to the *Staphylococcus aureus* favored by a predisposition on the part of the patient. Sabouraud[67] states that simple blepharitis is probably an infection with one of the common micro-organisms.

To determine the nature of the bacterial infection, if one exists, is no easy matter, for a large variety of micro-organisms have been found on the normal lid borders and occasionally they show a moderate degree of virulence. This was well shown by Cuénod,[68] who produced corneal abscesses in rabbits with cultures of the *Staphylococcus aureus* taken from the normal ciliary margins. Thus in every observation it is not only necessary to cultivate the micro-organisms but to test their virulence and even then no certain conclusions may be drawn. Bayersdorfer[60] examined a number of cases of squamous blepharitis bacteriologically and obtained negative results. Cuénod,[68] in a series of thirty cases, found generally the *Staphylococcus albus,* often in pure culture; various other bacteria, mostly cocci, were obtained. Virulence tests performed with the *Staphylococcus albus* colonies on the corneæ of rabbits showed almost no virulence and it was only by the injection of various of the mixed cultures that he obtained severe lesions. He concludes:

> D'une façon générale si nous comparons les cultures obtenus de bords ciliares normaux, et celles obtenues dans les cas de blépharite simple, nous notons en faveur de ces dernières leur abondance et leur extrême fertilité. Au point de vue de la virulence, elle ne nous a pas paru plus notable, et c'est la où là nature du terrain nous semble jouer un rôle supérieur à celui du microbe.

Winselmann,[70] speaking more especially of ulcerative blepharitis, believes that the first requisite for a blepharitis is hyperemia of the lid border to prepare the soil for the growth of bacteria. Roeder,[71] on the other hand, believes all blepharitis to be secondary to disease of the conjunctiva and of the tear sac. That a secondary blepharitis may occur in connection with an infection of the tear sac or the conjunctiva is a matter of daily observation. We can hardly go so far as to endorse Roeder's opinion. It is well established that the diplobacillus of Morax and Axenfeld has a special tendency to involve the lid margins and especially the angles; but this gives a very different picture from the ordinary squamous blepharitis. It seems probable, as Cuénod observes, that the nature of the soil plays a more important rôle than do bacteria.

## ULCERATIVE BLEPHARITIS.

In a large majority of the cases of this disease the *Staphylococcus aureus* is the infecting agent; less frequently are other varieties of staphylococci met with. Widmark[72] found staphylococci in the small abscesses of the ciliary border, as did Gallenga.[73] In fourteen cases of ulcerative blepharitis Cuénod[68] found the *Staphylococcus aureus* eight times pure, the *Staphylococcus albus* four times pure, and twice found the two forms mixed. He proved the high virulence of all cultures containing the *S. aureus*, and obtained but little reaction from the *S. albus*.

Bayersdorfer,[69] in a series of cases, found the *S. aureus* always present and the *S. albus* also in about one-half the observations. Once he found the ***Penicillium glaucum,*** probably an accidental contamination. Herzog[74] obtained mostly staphylococci in his studies, but he was able to stain and to cultivate a diplococcus resembling the *Diplococcus albicans* which was found by Tommasoli in eczema, and a similar organism was described by Unna in a case of eczema secondary to pemphigus.

In a recent article McNab[75] asserts that a majority of cases of ulcerative blepharitis and that a vast majority of the long-standing chronic ones are due to infection with the diplobacillus of Morax and Axenfeld, that this organism may be found in the secretions of most cases and that a secondary infection of the follicles with pus organisms takes place. That an infection of long standing due to the diplobacillus may prepare the way for a secondary infection of the lid in a certain number of cases is not to be doubted. That a vast majority of the long-standing cases of ulcerative blepharitis rest on this basis can hardly be accepted, however, without sufficient proof, and McNab brings forward no evidence in support of his statements. So far as our knowledge goes at present, it is the staphylococci only that are concerned in the direct production of this disease. What part may be played by other organisms such as the diplobacillus and the xerosis group is for future investigation to decide.

Taking up now the classification and the various etiologic factors other than bacteria, we find a wide difference of opinion. Herzog,[74] Fuchs[17] and most of the text-books say that it is an eczematous process. Sabouraud[67] believes it to be a simple infection with pyogenic microbes in individuals who are subject to infection with pus organisms. The reason, therefore, we know little or nothing about. Some class it as acne, some as sycosis. Truc[76] and Roeder[71] believe it an infection always secondary to disease of the tear passages. Winselmann[70] believes that it is a primary disease of the ciliary roots induced by hyperemia.

According to Roeder, the mechanism is as follows: The normal tears, even if present in increased quantity, as in simple stenosis of the nasolachrimal duct, are prevented from penetrating into the hair follicles by the sebum; let now an infection take place, be the microbic cause what it may, pus is formed and a fat emulsion is produced which overcomes the protecting products of the sebaceous glands and penetrates the follicles, producing irritation and infection. The tissues swell, the follicle becomes occluded, the pus collects, forms a cavity and later finds its way to the surface.

As the first requisite, Winselmann assumes a hyperemia of the lid border which may be due to many causes, such as dust, smoke, bad air, light, ametropia or scrofulous constitution. This prepares the ground for the ever-present bacteria, and a primary infection of the roots of the cilia takes place. Thus the disease should be classed as a sycosis and is in no way related to eczema. Fuchs holds that it is an eczema which, owing to the presence of hair structures, suppurates as is common in eczema of other parts of the body where hair is present.

In his exhaustive article on the diseases of the cilia, Herzog[74] holds that the disease must be regarded as an eczema and that it develops in ocular conditions in which there is increased secretion of fluid. In beginning and course it can show all the characteristics of an acute infection. Particularly when it has existed a long time an inflammation of the follicles takes place regularly. Contrary to Unna's opinion, this is not to be regarded as a complication, but as a true eczematous involvement of the follicle. Herzog also holds that, in spite of the present inclination of dermatologists to exclude pustular affections of the epidermis from among the eczematous eruptions, the pustular folliculitis of the cilia follicle must be regarded as the summit of an eczematous process, and, although this process is not characteristic of the eczematous processes of the ordinary skin, it is logical and characteristic in this region. The micro-organisms penetrate along the hairs, find a more favorable soil here than in the epidermis and, therefore, have a more toxic action; they tend to remain in the follicles and thus the process often recurs and becomes chronic.

Such are the principal views of the present day.

## HORDEOLUM.

The hordeolum is the furuncle of the ciliary border and differs in no way in its bacteriology from the furuncles of other parts. The classical description of hordeolum recognizes an external form, an inflammation of a gland of Zeiss, and an internal form or inflammation of one of the meibomian glands; the course and symptoms of the two varieties differing, as one would expect, from the very dissimilar anatomy of the two regions.

Axenfeld[77] demonstrated sections of hordeola in all four lids of a child, showing all stages of the process. The ciliary follicles were found full of cocci and showed surrounding necrosis varying in amount with the size of the swollen follicle; there was evidence of a severe sequestrating inflammation which finally led to expulsion of the infected tissue and to the formation of an ulcer. On the lid border corresponding to the cilia follicle in depth were large furuncular abscesses. A point of especial interest, however, was the fact that the sweat glands occasionally formed the starting point of the process, since occurrence of furuncles of the sweat glands has been contested. From this case alone it must be allowed that the hordeolum externum can originate in the hair follicle, sebaceous gland or sweat gland. Thus Herzog[74] believes that the inflammation in some cases may simply be a step farther in ulcerative blepharitis, a more extensive infection leading to acute symptoms and abscess formation starting from a follicle already infected. That hordeoli are common in ulcerative blepharitis is well recognized and that furuncles of the lanugo hair frequently occur in its course he lays stress on.

Regarding the predisposing causes, blepharitis of greater or less intensity is naturally the commonest, and when that is lacking there must be some means of infection from without as in lesions of the lid border produced by removing forcibly the dried secretion of a conjunctivitis. In addition we have the causes of blepharitis mentioned before.

Hordeolum is very frequently designated as acne of the lid border. Acne is defined as an inflammation of a sebaceous gland. The infection of a hair follicle is termed sycosis and of a sweat gland as an hydradenitis. On the other hand, it has been shown that a furuncular (hordeolar) infection may start from any one of these three structures so that in these acute, localized infections of the lid border it would seem that hordeolum is the best name to use.

## TARSITIS NECROTICANS, ETC.

Under this title Mitvalsky[78] describes an inflammation starting in the meibomian glands and due to the ordinary pus organisms. Instead of following the course of the common hordeolum internum, this process extends and produces necrosis of the neighboring parts of the tarsus. A sequestrum is formed and extended through the inflamed conjunctiva. The necrosis seems confined to the breadth of two meibomian glands and may affect the whole vertical section of the tarsus. Maklakow[79] reports an inflammation of the meibomian glands with dilatation of their ducts and thickening of the tarsus in a patient who had had ozena for seven or eight years. In both the secretion of the nose and of the eye could an ozena bacillus be found which was pathogenic in the vitreous of a rabbit. Tarsadenitis meibomica, according to Weymann,[80] is a subacute or chronic infection of the meibomian glands, with a tendency to alterations in structure supposedly due to a diffusion of chalazial products throughout this region.

## CHALAZION.

Chalazion is a chronic inflammation of a meibomian gland with the formation of granulation tissue. Of its cause we know little or nothing as yet, although many investigators have tried hard to solve the problem of this little tumor. A number of different micro-organisms have been found in chalazia, among them many of the pus organisms, the *Bacillus xerosis* and rarely the Morax-Axenfeld diplobacillus, the *Bacillus pneumoniæ* and the bacillus of tuberculosis.

The latter organism was seen under the microscope by Baumgarten,[82] Wichert[83] and Tangl,[84] and this gave rise to the doctrine that all chalazia were of tubercular origin. Numerous animal inoculations have been carried out, but always with a negative result, except in one case reported by Henke,[85] in which the material was taken from a child who died of tuberculosis. Nevertheless Baumgarten, Landwehr,[86] Wichert and others still affirm that chalazion is often tubercular. Most authorities agree that, while tuberculosis of the tarsus may rarely present a clinical resemblance, the true chalazion is an entirely different process.

Deyl,[87] in 1893, obtained from this growth a bacillus belonging to the xerosis group, and succeeded in producing similar tumors by injecting large quantities of these organisms under the conjunctiva. It must be remembered, however, that xerosis bacilli may occur in the normal glands, and furthermore that in Deyl's experiments relatively enormous quantities of the germs were used.

Recently Bietti[88] has published the results of his researches. He succeeded in finding Deyl's bacillus in seven out of twenty chalazia. In four he found the *Staphylococcus albus,* in one the *S. albus* and pneumococcus mixed, in one the *S. aureus* and in seven the result was negative. He succeeded in producing experimental chalazia by injecting both living and dead cultures of both xerosis bacilli and also diptheria bacilli, also when the animal was immunized with diphtheria antitoxin and when antitoxin was mixed with the cultures. He also got positive results on injecting the *Bacillus prodigiosus,* the rose yeast fungus, the pseudo-gonococcus, the *Staphylococcus albus* and others. He concludes that all these germs simply produce inflammation as would a foreign body and that no specific power in the production of chalazion can be attributed to the xerosis bacillus. Axenfeld[81] also observes that these bacilli are not constantly found, disappear early in the process and rarely show pathogenic action on guinea pigs. How closely bacteria are concerned with this process awaits future investigation.

## TUBERCULOSIS.

In 1867 Langhans[91] inoculated tubercular material into the conjunctiva of a rabbit and produced general tuberculosis and death. In 1873 Koester[92] reported a tubercular granuloma of the conjunctiva. In 1879 Haab[93] reported thirteen observations, six personal, on the primary tuberculosis of the conjunctiva. This, however, was before the days of Koch's bacillus and probably the first exact observation of ocular tuberculosis was that of Parinaud[94] in 1884, who inoculated a rabbit with the scrapings from an ulcer of the tarsal conjunctiva with a positive result. Since then there have been a large number of observations, many of which have come from France. In 1903 Douvier[90] in his inaugural thesis collected thirty-five cases of tuberculosis of the lids and from his article and from Groenouw's[1] compilation I have obtained a large amount of material. As, however, a considerable number of the cases reported as tuberculosis of the lid affect only the conjunctival surface, they will be considered elsewhere.

The bacillus of tuberculosis may produce a large variety of lesions, owing in part to the varying virulence of the strain, to the anatomic peculiarities of the part affected and to local and general resistance. Lupus is the commonest form of tuberculosis of the eyelids and this is not peculiar in view of the fact that tuberculosis of the skin is not a rare effection and has its seat of election in the face. In an analysis of 374 cases by Bender[96] the face was involved in 287 and the nose in 70 more, thus it may be seen that the lids are affected secondarily with considerable frequency.

Primary lupus of the eyelids, however, must be considered uncommon. Block[97] observed it twice in 387 cases. On the face it presents no variation from lupus of the other regions of the skin, but appears first in the form of small, deep-seated brownish red macules of varying size or as small discrete nodules or infiltration of soft consistency situated in the corium. The disease develops slowly, new lesions form on the borders and an area or patch of varying size is developed. The individual nodules remain small, break down and form shallow ulcers with borders shading into red and brown with a scanty secretion and often crust formation. Cicatrization then takes places, the resulting scar being thick and tough and exhibiting a considerable degree of contraction. As the progress of the disease is slow all these forms may be seen within a comparatively small area. As the result of the process a considerable degree of ectropion is often left behind.

Lupus is by no means limited to the skin but may extend to the conjunctiva of the lids, globe and tear sac, it may involve the globe. Conversely it may originate in the conjunctiva and involve the skin and other structures of the lid secondarily. This is the second type to be considered. Even when the disease is confined to the conjunctiva of the tarsus the lid may appear swollen, thickend and may show a considerable degree of ptosis. Involvement of the tarsus may not take place, it may take place to a slight degree or it may be very extensive in amount and resemble syphilitic tarsitis as in the case recently reported by Rollet,[98] which is claimed to be a hitherto undescribed form of tuberculosis of the lid.

Certainly his case is a very marked example of this variety of the disease, but that occasional cases of diffuse involvement of the tarsus have ben observed, is demonstrated by a case reported by Bach[99] in 1894. Not only may the tarsus be affected by the disease, but the whole thickness of the lid may be involved and ulceration may extend from the tarsal surface around the ciliary border. The symptoms and appearances vary with the extent of the disease, from slight thickening, edema and ptosis to a very considerable enlargement, an almost brawny induration with a marked degree of edema and redness of the skin, depending in part on how near the surface the disease has progressed. Occasionally, as we have seen before, tarsal tuberculosis may develop as a single focus, resembling a chalazion, or there may be multiple nodules situated in the muscle tissue as in Schmidt-Rimpler's[100] case. Occasionally there is a development of nodules resembling hordeola in the lid border (Braunschweig[101]) or a blepharitis (Gerin Roze[102]). Rarely a local tuberculous process, from direct inoculation, with abscess formation develops in the lids as in the other parts of the body. Such a process is well described by Stutzer.[103]

Capauner[104] described a lupus of the lid complicated by carcinoma and Ginsberg[105] remarks in this connection that in a chronic ulcerative process of this kind affecting the skin the histologic picture may be such as can not be distinguished from that of a beginning malignant growth. Another form is the cold abscess extending into the tissues of the lids and originating from tuberculosis of the neighboring bony structures (Gallemærts[111]).

An atypical form as represented by Rollet's case published in Douvier's thesis must be mentioned. This was tuberculosis developing in the tissues of the lower lid and causing direct infection from the contents of a lacrimal sac which had been forcibly ruptured. The tumor was the size of a large sector cut out of a mandarin orange and was filled with pus and caseous material. The skin was of a purple color. One of the commonest accompaniments of tuberculosis of the lids and conjunctiva is enlargement of the neighboring glands, an important feature from the standpoint of diagnosis. The disease usually occurs between the fifth and thirtieth year of life, but occasionally is seen in those of more advanced years and also in the very young.

Sticker[106] believes that in skin tuberculosis infection takes place through the lymphatics from a primary lesion in the nose. Leloir[107] gives five possible routes for infection to follow. 1. Direct inoculation. 2. Indirect inoculation by continuity from deep foci. 3. By the lymphatics or veins passing through foci more or less remote. 4. Infection of hematic origin. 5. Infection by inheritance. The first two are probably the usual methods. As mentioned before, a number of the cases of lid tuberculosis are secondary to involvement of the conjunctiva and there is no doubt that this membrane may be affected primarily as by particles of dust containing bacilli lodging in the sulcus subtarsalis and abrading the delicate covering (Fuchs[108]). A number of cases are reported in which the primary lesion was supposed to be in this locality as no other tubercular process could be found. Moreover this is the most frequent seat of conjunctival tuberculosis though occasionally it is seen first in the fornix or bulbar conjunctiva, from which situations it may extend to the lids, lachrimal sac and nose. More frequently the converse is the case.

Tuberculosis may follow a wound of the skin as in Stutzer's[103] case, in which the patient was bitten in the upper lid by a dog. It may follow a simple trauma without any demonstrable surface lesion.

Sometimes infection of the ocular structures is secondary to the disease in distant parts. In Grunert's[109] case there was phthisis, in Gerin Roze's[102] phthisis and laryngitis, in Fontan's[110] case there was a tuberculosis of the bones of the lower extremity and dissemination followed a curettage. In Gallemaert's[111] case it followed scarlet fever, in Parinaud's[94] case it occurred during convalescence from typhoid.

Tuberculosis may remain localized in the lids and disappear without involving other parts, but, on the other hand, an ever present tendency to spread is shown by the very constant enlargement of the neighboring glands. In Cheney's[112] case (tuberculosis of the conjunctiva) a child of eleven years developed phthisis secondarily (?) and died. In Armaignac's[113] case phthisis and tuberculous laryngitis developed. It should be borne in mind, however, that both the complications and the ocular process may be secondary to some deep-seated undiscovered lesion.

## LEPROSY.

That the ocular structures form one of the commonest sites for the lesions of this disease is recognized by all observers. It is probable that they are affected in from two-thirds to three-quarters of cases (Groenouw[114]). According to Lopëz[115] lesions will be found at some period of the disease in every case.

In an analysis of 480 cases Borthen[116] found the eyes and adnexa affected in 80 per cent., in 87 per cent. among men and in 74 per cent. among women. Profeta[117] puts the figures at 86 per cent. Boeckmann[118] in 62 fresh cases, 64 per cent., in 63 old cases, 75 per cent. The tubercular form preponderates; among 219 cases Borthen found 95 per cent. affected. In the macular anesthetic type Boeckmann found the ocular structures involved in 66 per cent. of 237 cases. In both forms the men were more often affected than were the women. In the mixed type Boeckmann saw 83 per cent. of cases, Kaurin,[119] 57 per cent. The eyebrows themselves are affected in about half the macular anesthetic cases and in practically all the tubercular.

Some writers describe three original forms of the disease, macular, tubercular and anesthetic, and all add a mixed type. In any case the different varieties usually shade into each other to a greater or less degree. The macular-anesthetic form is characterized by the development of reddish-brown hyperesthetic patches which later turn yellow and anesthetic; they may be accompanied by definite infiltrations. Later atrophy of the skin and of the deeper structures, the tarsus and the orbicularis may almost entirely disappear. Thus entropion and lagophthalmus are characteristic, due, in part, to the atrophy and sometimes to the involvement of the terminal filaments of the facial nerve (Lopez,[115] Bistis[120]). Bistis mentions a case in which one side of the face was completely paralyzed.

It may be mentioned here, though digressing somewhat, that Borthen[121] points out a fundamental difference in the relationship of the two forms to the ocular involvement. In the macular type the bulbar involvement is often secondary (ectropion, lagophthalmus and their results) and, therefore, not a genuine leprosy, while in the tubercular type, as long as it has not reached the anesthetic stage, the bulbar affections are, so to speak, independent, that is a true invasion of the *Bacillus lepræ.*

The tubercular variety is characterized by the development of small brownish nodules with a shining surface, generally appearing first in the region of the eyebrows and later in the lids proper. In the lid border they may also develop and resemble little chalazia. The nodules become confluent and may reach such a size that almost complete ptosis results. A more common appearance, however, is the knotty, furrowed, projecting eyebrow. The nodules are divided and crossed by furrows, and the lid region may be cut into two equal halves by the fibers of the corrugator. Ectasia (Jeanselme and Morax[122]) of the superficial veins may take place and ulceration also in both forms with absorption of the nodules and the formation of scars. The hairs are early and markedly affected in both types, the disease usually beginning in the outer half of the eyebrows and later extending to the lashes. The hairs sicken and fall out, giving a characteristic appearance as the hair of the scalp is not affected. Ectropion is common, distichiasis is sometimes seen, while ectropion occurs rarely, according to Lopez[115] and Bistis.[120] The course of the disease extends over many years.

Leprosy occurs most frequently between the ages of 30 and 50. Our knowledge of the incubation period is indefinite, but it seems to be very variable, from several months to many years. The site of inoculation is not known; according to Sticker,[123] the primary lesion is almost always an ulceration in the cartilaginous septum of the nose. Out of 153 cases he found this process in all but 13, and in 9 of these the nasal secretions contained many *Bacilli lepræ.* Geill[124] has called attention to the fact that among barefooted people in the Dutch East Indies the first signs of the disease were observed on the feet in 50 per cent. of the cases.

General dissemination of the disease takes place in all probability by means of the lymphatics, occasionally through the blood current. The means of contagion from one individual to another are not known; possibly there is an intermediate host. Intimate contact seems to be necessary. *Bacillus lepræ* was discovered by Hansen in 1871, but up to the present time cultures and inoculations have not given satisfactory results. The micro-organisms occur in clumps or groups. Virchow,[126] Neisser[126] and many others believe that they occur within the large cells so characteristic of this disease, while Unna[127] and Herman[125] maintain that for the most part they lie free in the lymph spaces and vessels, blood vessels and connective tissue. They are found also in the walls of vessels, in the nerve sheaths, in the rete mucosum of the skin and particularly around the hair follicles. Leprosy tubercles consist of an infiltration made up largely of leucocytes and to a lesser degree of cells which have arisen from proliferation of the fixed connective tissue cells. A vessel is generally found in the center of the nodule (Ginsberg[128]).

### GLANDERS.

Before the days of bacteriology Krajewski[130] described the case of a child who developed an ulceration on the right lower lid and a small hard nodule, which later necrosed and became gangrenous, on the left upper lid. There was enlargement of the neighboring glands, fever and delirium. The child was supposed to have contracted the disease from a horse affected with the lesions of glanders. In Neisser's[131] case there was an ulcer of the lower lid near the inner canthus, also abscesses and ulcers on other parts of the body. Tarnowski[132] saw pustules forming on the lid and elsewhere in a patient who had been infected by a bite on the arm. Gourfein[134] saw a slight ectropion following extensive loss of substance on the cheek and in the neighborhood of the tear sac due to glanders. Tedeschi[133] was able to produce the lesions of glanders on the lids of guinea-pigs by injection of the bacillus into the anterior chamber. Extensive involvement of the upper lid took place with destruction of the tarsus and ulceration. Thus the lesions of glands are rarely found in connection with the ocular structures and on the lids show no peculiarities of importance.

### TETANUS.

Fromaget[135] has collected a large number of cases in which infection of the ocular structures by Nicolaier's bacillus has produced typical tetanus. Occasionally a wound of the eyeball itself has been the starting point, but in most cases entrance has been through a lesion in the lids, and, as would be expected from its exposed position, the orbital border is the commonest site of involvement.

The injuries have been of all descriptions from small surgical incisions to extensive lacerating traumatisms. but, as is usually the case in tetanus, the comparatively insignificant wounds have predominated. Out of some eighteen or twenty cases there were several cases of the so-called cephalic type. In tetanus there can be an involvement of the musculature of the lids showing itself in spasm or paralysis of the orbicularis and paresis or paralysis of the levator palpebræ. In the literature section will be found references to a number of the cases.

### ALEPPO BOIL.

This is a local infection of the skin endemic in certain tropical regions and known also as Delhi sore, Biskra button, Orientbeule (Ger.). All parts not covered by the clothing are affected, among them the lids. The disease begins as a red macule and steadily grows to form an elevated indurated area which may reach the size of a walnut. Ulceration takes place and later cicatrization. Various French observers have attributed the infection to a diplococcus, but more recent investigation by Wright,[153] confirming and amplifying the studies of Cunningham, Riehl and Firth, shows that it is more probably due to a protozoa. Willemin[154] has given a description of two cases in which the lids were affected and mentions hearing of a case in which the eye was destroyed by the disease.

### BUBONIC PLAGUE.

Calmette and Salimbeni,[158] in their observations on the Oporto epidemic, mention that pustules have been found on all parts of the body in this disease. and in one of their cases the conjunctiva was affected.

### BOTRYOMYCOSIS.

Ten Siethoff[159] records the following observation: The patient was a man who had been tending a horse affected with a fistula of the spermatic cord of botryomycotic origin. There was swelling of the lid border and the formation of nodules 0.5 to 3 mm. in diameter which resembled actinomycosis. On pressure an opaque glistening material containing typical colonies of the botryococcus could be expressed. The disease is occasionally seen in man and the cornea is rarely affected (Bargeton[160]). It is caused by a coccus resembling the *Staphylococcus aureus,* of which it may be a variety.

### RHINOSCLEROMA.

This is a disease starting from the mucous membrane of the nose and characterized by the formation of hard nodular masses composed of granulomatous tissue. An encapsulated bacillus, *Bacillus rhinoscleromatis*, resembling the pneumococcus, is found in the lesions. The tear sac is not uncommonly involved, and from this situation extension to the lids, orbit and eyeball may take place. In Zeissl's[161] case the skin of the lid and of the ciliary border were involved, in Schultess'[162] case the inner part of the upper lid and the inner wall of the orbit were affected.

### CYSTICERCUS CELLULOSÆ.

The cysticercus occurs rarely in the lids in comparison with the frequency with which it is found within the eyeball. I have been able to find but ten cases in the literature. The first observation was that of J. Sichel[165] in 1847. Canton[166] added a case in 1855 and Dolbear one in 1861. Four cases have been seen by Hirschberg,[169] who gave an historical résumé of the subject in 1892. Two other cases have been reported by Bull[170] and Streatfield.[171] It appears as a small, round, hard, elastic tumor either under the skin of the lids proper, or along the orbital border. On account of the thickness of the capsule it is non-fluctuant and the overlying skin is not attached, but freely movable. In size it varies between that of a pea and a small nut, depending somewhat on the character of the tissue in which it develops. The surface is smooth and it is not tender on pressure. In the case of A. Sichel and Gros[168] there were attacks of severe pain supposedly due to pressure on the supraorbital nerve, but the report does not state whether this symptom was relieved by the excision of the growth. In old cases tenderness and irritation of the skin sometimes develop. As is well known the cysticercus gains an entrance into the circulation from the digestive tract and may be carried to any part of the body.

### PEDICULOSIS.

This affection of the eyebrows and eyelashes, also known as phthiriasis, can hardly be regarded as a modern discovery, since it was known to Celsus and to Galen (Kraemer[173]) and since scattered observations concerning it have come down to us for two thousand years. Even in the immediate past it has been regarded as of rare occurrence. Hirschberg[175] saw but three cases among thirty thousand patients, Galezowski but two among his very large material, Schwenk nineteen among 19,819 at the Wills Eye Hospital in Philadelphia. Jullien[172] puts it at one in one thousand, and this is probably a fair estimate.

Cases have been reported in this country by Chisolm, Winfield, Hansell, Hooper, Stelwagon and others. Chisolm,[174] in 1891, at the Eye, Ear and Throat Hospital in Baltimore saw thirteen cases, and remarks that one or more cases are treated there each year. At the Massachusetts Charitable Eye and Ear Infirmary the condition is seen occasionally.

Kraemer[173] also believes that it is not so rare as figures tend to show, for it may not be recognized and is chiefly confounded with other affections of the lid border. The *Jahresbericht* for 1892 alone refers to eight articles on this subject.

Pediculosis of the lids is principally seen among those of dirty habits, but is occasionally observed among patients of the better class (Hirschberg,[175] Chisolm[174]). The pediculus pubis is the variety met with in almost all cases, for the pediculus capitis very rarely occurs in this situation. For some reason children form a very large percentage of the cases reported, although in them the natural habitat of vermin is undeveloped. Occasionally several members of the same family are affected. Infection takes place by extension from one part to another or from one person to another. Pediculi in the pubic region migrate to the lids and very rarely to the scalp.

The symptoms vary with the number of the parasites, from none at all to considerable itching, smarting and discomfort. In appearance there may be little to suggest the nature of the process, or there may be a condition simulating a blepharitis of the squamous or mild ulcerative type with small crusts or scales and little ulcers. The louse is of a dirty brown color and resembles a small scab; it adheres to the base of the cilia, and the head may be buried in the follicle. The nits are more conspicuous and give a nodular appearance to the lashes.

A feature of diagnostic importance is the presence on the lower lids of small reddish or brownish specks, the excreta, compared in appearance to specks of iron rust. The excreta are of an irritating character and often cause the ocular irritation seen in connection with pediculosis capitis. There are but two observations on the actual occurrence of this latter form on the lids. These comprise three cases, two reported by Bock[177] in 1892 in which the lice were present on the hair and eyelashes and not on the eyebrows. The other case was reported by Amman[178] in 1897. Both of these authors described the lid edges as being of a gray or yellow color, and Bock states that it was unlike the dirty gray tint characteristic of pubic lice.

## DEMODEX FOLLICULORUM.

This microscopic parasite, which is also known as acarus folliculorum, was discovered in the ceruminous glands by Henle in 1841 and in the sebaceous glands by Simon in 1842 and later in the hair follicles. In 1876 Michel discovered it in a lanugo hair follicle on the lid, in 1879 Majocchi[179] found it in the meibomian glands and also in the follicles of the cilia, where Stieda[180] also observed it in 1890, Burchardt[182] also found it in a chalazion. For a long time it was thought to be harmless, but now there is evidence to show that it may produce an abnormal pigmentation of the skin (de Amicis,[181] Dubreuilh) and that it or a closely allied organism produces a severe and sometimes fatal disease in dogs.

Raehlmann,[183] in 1890, ascribed to it a form of blepharitis (blepharitis acarica) characterized by diffuse hyperemia above the cilia, a slight swelling of the anterior lid margin and with a thick, yellow, honey-like secretion. Raehlmann and Reinhard found the demodex in only 1 per cent. of healthy lids and not at all in squamous and ulcerative blepharitis. His views have met with a considerable amount of discussion. Majocchi believes that this form of blepharitis is not a disease *sui generis*, but that it is dependent on some other process as a conjunctivitis. He states, however, that the demodex may cause hyperkeratosis, hyperplasia of the follicle sheaths and a perifolliculitis. Joers[184] examined fifty patients chosen at random and found acari in 64 per cent. He concludes that they are less frequent in disease and are not pathogenic. Hunsche[185] agrees with Joers.

Mademoiselle Stcherbatschoff[186] found these organisms in the cilia of about 50 per cent. cadavers, also seventeen times in the examination of 100 cilia from cases of blepharitis, but only once in 81 healthy lids. Thus the pathogenicity of these little organisms can hardly be regarded as proved; that it can cause some injury to the hairs and a pigmentation of the skin seems possible.

### INSECTS, ETC.

Principally through the observations of Carron de Villards[10] in the tropics do we know that a large variety of insects and the like may cause numerous affections of the lids through carrying extraneous infectious material or by the toxic substances which they themselves possess. The list includes various kinds of flies and mosquitoes, moths of several varieties, the brown tail is known to many of us here, bedbugs, woodticks, spiders, scorpions, leeches and many more. The lesions caused vary in severity from a mild erythema to severe infections and death.

### RINGWORM.

Involvement of the eyebrows and lid skin in ringworm (*Tinea trichophytina*) is probably not a very rare occurrence, though there are comparatively few allusions to it in literature. On the other hand, the cilia are but rarely affected and no case has as yet been reported in which the ciliary border has alone been involved. Cartaz,[187] in 1869, reported a case which in all probability was ringworm of the lashes, and Gailleton,[188] in 1889, added a single case. In 1894 Mibelli[189] published an important article on the subject, giving two cases of his own, quoting one seen by Pellizari and three seen by Majocchi in one of which the cilia was undoubtedly affected. Mibelli came to the conclusion that these four cases were the only authentic ones up to that time. Since then four have been added, those of Niclos[190] (1895), Dubreuilh[191] (1896), Voerner[192] (1901) and Snell[193] (1902). Voerner's study of the subject is fairly complete, and his case seems to be the only one confirmed by culture.

Formerly the ringworm was thought to be due to one fungus, the trichophyton, but during the last decade and owing chiefly to the indefatigable investigations of Sabouraud it has been shown that there are two divisions of ringworm fungi, first the microsporon of Audouin and, second, the trichophyton or megalosporon, which can be further subdivided and about which there is still much to investigate. Both of these forms occur in connection with eyelids, or both are composed of mycelium and spores. The disease is conveyed through the establishment of the fungus in the horny layers of the skin. Growth into the hair follicles takes place, subcorneal or intracorneal vesicles filled with serous or serofibrinous exudate are formed and the hair shaft proper may or may not be involved. The subcutaneous tissue is invaded by plasma and lymphoid cells and there may be a proliferation of the fixed cells. Suppuration may and frequently does occur. Both the upper and the lower lids have been affected. In those cases in which the ciliary border is involved the process at first sight may resemble an ordinary squamous or ulcerative blepharitis, but more careful observation will often show distinctive features, such as the formation of inflammatory foci of considerable extent, the rapid extension to neighboring cilia and the acute course of the disease. There is always redness and swelling, pustular points are not uncommon, and the cilia are broken and considerably distorted. The occurrence of lesions in other parts helps to establish the diagnosis.

## FAVUS.

In favus of the lids (*Tinea favosa*) we have another comparatively rare affection. Up to 1885 only four cases had been reported, but during the past seven or eight years there have been a number.

That the lids are not infrequently involved in favus universalis seems not improbable. I have made no extensive search to verify this statement, but in the recent article of Paulus[194] there are two such cases.

In a number of cases of sycosis of the lid border[195] Ellinger found a fungus resembling the *Achorion schoenleinii*, and Gunning made a similar observation in 1865. The identity of this organism with that of favus, however, has been doubted by later writers.

Narkiewicz-Jodko[196] reported a case of lid involvement in 1870. Arcoleo,[197] in 1872, in a case of favus capitis, found spores and mycelia on the eyelids. Schiess-Gemuseus[198] added a case in 1873 and McHardy[199] one in 1885. More recently the list has been enlarged by the additions of Sherwell,[200] Dervill,[202] Cuénod,[201] Pergens,[203] Libman,[205] Gloor,[204] Schmidt-

Rimpler[206] (two), Van der Wijk,[207] Collins[208] and Pecoraro.[209] One of the most recent articles on the subject is that of Pecoraro in which a résumé of the cases and of the literature is given.

Favus is due to the achorion, discovered by Schoenlein in 1839, a vegetable parasite composed of mycelia and spores. According to Crocker,[210] five varieties of the fungus have been described, but it is doubtful if any but the one above mentioned is concerned in the production of favus.

The disease is more likely to occur among persons of low vitality and dirty habits, and there is possibly an individual peculiarity of the skin in those affected. It may be communicated from one person to another or to man from the lower animals, particularly the cat. In order to produce the disease the parasite must be established in the epidermis, which in the case of the constantly moving lid is a difficult matter. Pecoraro[209] believes that this may account for the relative infrequency of lid involvement. According to Robinson, the parasite lodges first at the opening of a hair follicle and grows down into about half way to the root; in the skin it vegetates superficially and only seldom penetrates into the deeper layers. The first noticeable sign is a reddish and slightly scaly spot, insignificant in character, next yellowish crusts appear around the lanugo hair follicles and grow to the size of a pea, showing a cup-shaped depression in the center (the scutulum). If these crusts be removed they show a reddish underlying surface. The crusts become confluent and form masses occasionally traversed by concentric furrows. The hairs are involved early, become brittle and break off. The upper lid is more often affected than the lower and generally the ciliary border is not involved. In the report of Collins'[208] case will be found a colored plate showing the appearance of the disease on the lid.

## BLASTOMYCOSIS.

The organisms which cause this disease may be tentatively classed under the name of oidium (Link) and are a genus of the yeast family (*Oidiomycosis cutis*). The *Oidium albicans* was the first of these organisms to excite medical interest as far back as 1840, when it was recognized as the cause of parasitic stomatitis. Busse, under the title of "Saccharomycosis hominis," published in 1894 an account of a case of pyemia caused by a pathogenic yeast.

Curtis, in 1896, described a case of myxomatous-like tumors caused by a yeast-like organism. Gilchrist, in 1896, was the first to describe a skin disease due to a yeast-like organism, naming the disease "blastomycetic dermatitis." In his second case the skin of the eyelids was affected. Ricketts[212] concludes that the protozoic disease of Posadas, Wernicke and others, saccharomycosis and blastomycetic dermatitis, are various manifestations of the same disease. Since that time over forty cases of cutaneous blastomycosis have been reported, and in at least ten the skin of the lids has been affected. Thus the eyelids must be regarded as a favorite seat of the disease.

Pusey believes that 50 per cent. of the cases show lesions of the lids, and that in most of these the disease is primary there. A very large majority of the cases have occurred in the vicinity of Chicago. The most notable recent general consideration of the subject is that of Ricketts,[212] while the ophthalmic side of the disease is well treated in the articles of Montgomery,[213] Wood[214] and Wilder.[215] Rosenstein,[216] in 1904, reported an ulcer of the lower lid, in which he found a pure infection with yeast organisms. He regarded the case as unique, but was evidently unacquainted with the observations on blastomycosis.

The blastomycetes appear as rounded, doubly-contoured, vacuolated bodies, often seen in pairs and also as budding forms. In cultures they show mycelia, but not in the tissues. They produce a large amount of epithelial hyperplasia and form small abscesses in the epithelium and granulation tissue studded with small abscesses in the corium.

Infection is probably always due to the implantation of oidium spores on a surface from which the surface epithelium has been removed. The initial lesion starts as a small papule which soon becomes covered with a crust. It spreads gradually and appears as a flat, deep red, warty, slightly elevated growth, containing many small abscesses and showing but little tendency to ulcerate. The purulent contents of the abscess contain the organism. As the disease progresses, healing of the part originally affected may take place, the resulting scar being soft, smooth and rather flexible.

## ACTINOMYCOSIS.

Actinomycosis of the jaw affecting the soft parts of the face may cause a considerable swelling of the lids. There is no observation, however, of the disease having its primary seat in the palpebral structures. Partsch[217] reports a case in which the upper jaw became involved probably from a carious tooth. Swelling of the lids followed and a small nodule appeared on the upper one, which, when excised, showed a typical actinomycosis. Darier and Gautier[218] observed in a patient an indurated swelling of the right cheek attached to the superior maxilla. The lower lid, especially its outer half, was the seat of a soft edematous infiltration, and the skin was of a pale reddish color. Here also actinomycosis was found.

In 1887 Fienzal[220] described an ulcer, situated near the border of the lower lid, which had a yellowish surface and sharp borders. Around its border pustules developed slowly. There was considerable pain and a swelling of the preauricular gland. From both the ulcer and the pustules a fungus was obtained, but its nature was not determined.

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# THE PATHOGENIC BACTERIA OF THE CONJUNCTIVA.*

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Our knowledge of the micro-organisms which produce pathologic conditions on the human conjunctiva, of their occurrence in various sections of the world and of the conditions necessary for their growth is becoming gradually more exact, although many points are still in dispute and await further accumulation of facts.

We know definitely that the same form of inflammation of the conjunctiva can be produced by various organisms. Examination of acute catarrhs, as well as of the purulent and pseudo-membranous forms of conjunctivitis, shows that cases which are clinically indistinguishable may contain bacteria that are morphologically very different. It is further definitely proven that one organism may produce various types of conjunctivitis, according to the conditions present and to the virulence of the organism, and that certain forms may exist in the conjunctiva at times without causing any reaction. Much, therefore, depends on the individual constitution or predisposition of the person affected and the conditions present in the conjunctival sac at the time of infection.

We recognize, moreover, that certain micro-organisms are more independent of these conditions than others, and that the earlier division of the bacteria into those which are "conditionally contagious," such as staphylococci, streptococci, pneumococci and diphtheria bacilli, and those which are "unconditionally contagious," such as the Koch-Weeks bacillus, the diplobacillus of Morax and Axenfeld and the gonococcus must be still considered as practically correct, despite the occasional occurrence of the last named organisms (with the possible exception of the Koch-Weeks bacillus) on the normal conjunctiva. The special conditions which favor the growth of the various organisms have been developed in a series of valuable papers by Uhthoff,[1] Sourdille,[2] Lagrange,[3] Wolkowitsch,[4] Cramer,[5] Lobanow[6] and Römer,[7] which have been critically reviewed by Professor Axenfeld.[8]

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### METHODS OF INFECTION.

It is to another phase of the subject, however, that I desire to call attention, viz., the method of conveyance of the contagion.

*Direct Contact.*—It is no doubt true that the method of direct contact, of conveyance of the secretion containing the specific micro-organism from the eyes of the affected individual by means of fingers, towels, handkerchiefs, washing utensils, etc., must still be considered as the one which obtains in the majority of cases. That this, however, is the only way, as has long been taught, is open to doubt.

*Dust Infection.*—The spread of acute contagious conjunctivitis in schools and asylums, despite careful precautionary methods adopted by those in charge, and in an epidemic form in places where the individuals do not come in close contact, raises the question of whether infection can or can not be transmitted by the air. On this subject a great deal of experimental work has been done, particularly in the German laboratories and also in this country.

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2. Sourdille: Arch. d'Ophtal., vol. xiv, January, 1894.

3. Lagrange: Ann. d' Oculistique, vol. cxxi, p. 128.

4. Wolkowitsch: "Versuche über die Bedingungen der Infektion der Conjunctiva," Diss., St. Petersburg, 1899.

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~~6. Lobanow: Westnik ophth., vol xvi, p. 500, 1899; also vol.~~ xv, pp. 3 and 215.

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8. Axenfeld: Lubarsch and Ostertag's Ergebn. d. Allg. Path. u. path Anat. d. Mens., 1899.

The important work of Flügge,[9] published in 1897, proved conclusively that the contagious diseases can be so carried, and that bacteria mixed with dust remain flying in the air for hours, and that very slow currents of air are capable of spreading the ordinary room-dust throughout a room and into adjoining chambers. He showed that the requisite condition for the transmission of organisms in the air was their ability to withstand drying, and as the result of his experiments and those of investigators working along the same lines, notably Neisser,[10] Laschtschenko,[11] Germano[12] and others, bacteria have been divided into separate classes.

The first group contains the cholera, plague and typhoid organisms, which die rapidly in the dust, and so under natural conditions are probably not carried through the air. In this class are probably to be placed the influenza bacillus and gonococcus.

A second group includes streptococci, pneumococci and diphtheria bacilli, which resist drying for from three to six months, especially in secretion, although some forms of the pneumococcus are as susceptible as the cholera bacillus.

In a third group are the *Diplococcus intracellularis*, the cause of epidemic cerebrospinal meningitis, which possesses extremely high resisting power to drying, *Staphylococcus pyogenes* and the tubercle bacillus.

In a fourth group might be placed the spore-forming organisms, such as anthrax and tetanus, which have an almost unlimited vitality in a dried condition (Germano[12]).

*Droplet Infection.*—In addition to this method of dust infection we are indebted to Flügge and his assistants for the discovery of a second method of contagion, which is of almost equal importance, viz., by means of fine drops. It has been shown that by an ordinary spray apparatus a solution containing prodigiosus culture may be atomized and the drops will be carried to all parts of a room and remain suspended in the air for from two to five hours. The method is of especial importance in

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9. **Flügge**: "Ueber Luftinfection," Zeits. f. Hyg. u. Inf., vol. xxv, 1897.
10. **Neisser**: "Ueber Luftstaubinfection." Thesis, 1898.
11. **Laschtschenko**: Deuts. med. Wochft., 1898, p. 134.
12. **Germano**: Zeits. f. Hyg. u. Inf., vols. xxiv, xxv, xxvi, 1897.

connection with diseases which are accompanied by coughing and spitting; Flügge's experiments proved that every cough, sneeze or outcry sends fine drops of sputum in large number into the air and that these droplets may likewise remain flying in the air for hours. This method for the spread of pulmonary tuberculosis was recognized as early as 1884 by Koch, and was fully demonstrated by Laschtschenko[11] in Flügge's laboratory and by Curry[13] in this country, while Goldie[14] and Boston[15] have shown that in ordinary talking consumptives expel droplets which can be caught on a glass plate held in front of the mouth, and that these drops can be shown to contain tubercle bacilli.

For these diseases of the respiratory organs, therefore, the causes of which do not retain their vitality after drying, and can not exist in the air, in the form of dust, the inhalation of atomized drops is doubtless a frequent and dangerous way of infection, ranking with contact, especially for persons who are only visitors to the patient and are not nursing or washing utensils, linen, etc. (Flügge).

The importance of this matter in connection with the diseases of the eye, while hitherto but little considered, must be appreciated.

In all forms of catarrhal conjunctivitis which are associated with well-marked secretion, the organisms may be carried downward through the lachrymonasal duct into the nose and throat and from there be expelled in the acts of talking, sneezing and coughing. Lobanoff's[16] article was a valuable contribution to the subject. He reported a case in which diplobacilli were present on a sore spot at the angle of the mouth for a long while. Biard[17] found diplobacilli in the nose in twenty-eight out of thirty cases examined, even in the absence of conjunctivitis, although the correctness of his results has been disputed by Morax and Petit[18] and by Zur Nedden.[19] Erdmann[20] in 1905 found an organism corresponding exactly to the Morax-Axenfeld bacillus in the nose in forty-two out of sixty-seven cases of diplobacillus conjunctivitis. For the pneumococcus and Koch-Weeks bacillus this infection of the nose as a result of the well-marked conjunctical secretion is especially to be considered.

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[13] Curry: Boston Med. and Surg. Jour., Oct. 13, 1898.

[14] Goldie: Canadian Pract. and Rev., August, 1899.

[15] Boston: THE JOURNAL A. M. A., Sept. 14, 1901.

[16] Lobanoff: "Ueber die Bedeutung der Luftinfektion für des Auge," Arch. f. Ophth., vol. li, p. 431, 1900.

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[18] Morax and Petit: Ann. d'Oculist., vol. cxx, p. 161.

[19] zur Nedden: Klin. Monats. f. Augenhk., January, 1902.

[20] Erdmann: Klin. Monatsbl. f. Augenhk., vol. xliii, May, 1905.

Pneumococcus rhinitis and bronchitis are often associated with pneumococcus conjunctivitis, and as the spread of pneumonia and influenza must be accounted for at times by the occurrence of drop infection, so the possibility of this drop infection in contagious diseases of the conjunctiva must always be thought of, particularly in schools. The spread by dust infection is of less importance, as the special bacteria of the eye are but slightly resistant to drying. The carrying of the secretion by flies must also be a factor of importance, particularly in regions such as Egypt, where there is a lack of the ordinary hygienic precautions and care in cleanliness, and even in hospital and infirmary wards unless patients are screened. It is important, moreover, to recognize that the organisms are much more resistant to drying when they are protected by the secretion than when in pure culture, and many retain their virulence as long as they remain moist. Further experiments along these lines, such as were conducted by Erdmann[20] for the diplobacillus, should prove of value in making our knowledge of the transmission of the contagion more definite.

## BACTERIA ENUMERATED AND DESCRIBED.

The morphology, staining and cultural peculiarities of the individual organisms which are pathogenic for the conjunctiva are now fairly well determined, and in considering the bacteria I shall place particular stress on the facts which have been determined concerning the resistance of the cultures, the probable methods of conveyance of the infection and the conditions necessary for their growth in the conjunctiva. As the bacilli of tuberculosis and leprosy have been discussed in another paper in connection with the pathogenic bacteria of the lids, they will be omitted here.

1. *The Koch-Weeks Bacillus.*—This minute organism, first discovered by Koch,[21], and later more carefully

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[21] Koch: Arbeiten aus dem Kaiserlichen Gesundheitsamt, vol. III, p. 19.

studied by Weeks,[22] Kartulis,[23] Morax,[24] Weichselbaum and Müller[25] and Hofmann,[26] is 0.25 micron wide and from 0.5 to 1 micron, more rarely 2 microns, long. The shorter forms are often found in pairs; their ends are rounded and there is occasionally a polar staining. The bacillus is decolorized by Gram's method and is best stained with dilute carbol-fuchsin and watery solution of gentian violet, but does not stain so deeply as the ordinary pus cocci.

In the secretion it is found both in and between the pus cells and is often associated with the xerosis bacillus, occasionally with isolated cocci, which are liable to conceal it in the culture media. It is obtained in pure culture with considerable difficulty. Of the ordinary media only very moist dilute 0.5 per cent. peptone agar of not too great alkalinity is available, and only when the organism possesses full virulence. Ordinarily it requires special media, of which the best are serum agar and serum bouillon. The presence of xerosis bacilli or staphylococci in the culture favors its growth (Rymowitsch[27]). The colonies appear at the end of from twenty-four to forty-eight hours as round, transparent, glistening drops, which resemble those of the influenza bacillus. In serum bouillon a delicate diffuse opacity is formed, which sinks to the bottom of the tube. In cultures the organisms show long involution forms and are non-motile.

They lose their vitality rapidly, and after five days can usually not be reinoculated. They are readily killed by heat, a temperature of 60 C. destroying them within fifteen minutes. The experiments of Weichselbaum and Müller[25] showed that after drying the secretion in Petri dishes for six and one-half hours the organisms could not be cultivated, and after eight hours they were unable to infect the human conjunctiva. Hofmann likewise found that the bacilli lost their vitality after exposure to drying for three hours at a temperature of

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[22] Weeks: Arch. f. Augenhk., vol. xvii, p. 318, 1887.

[23] Kartulis: Centbl. f. Bakt., vol. i, 1883.

[24] Morax: "Sur l'etiologie des Conjunctivites aiguës." Thèse de Paris, 1894; Ann. d'Oculist., vol. cxxix, 1903, p. 156.

[25] Weichselbaum and Müller: Arch. f. Ophth., vol. xlvii, p. 108, 1899.

[26] Hofmann: Zeits. f. Hyg. u. Inf., vol. xxv, 1897; Centbl. f. Bakt,. vol. xxviii, p. 353, 1898.

[27] Rymowitsch: Wratsch., vol. xx, p. 638, 1900 and 1901.

20 C. They are, therefore, but little resistant to drying and can probably not be carried by the dust.

On the other hand, in the presence of abundant secretion they may be readily carried into the nose and communicated by Flügge's drop method or be carried by flies. Water may serve for a short time as a carrier of infection, but infection by direct contact is probably the most frequent method.

The bacilli are unconditionally contagious for the human conjunctiva, all inoculations of the pure culture proving successful, and an immunity after one attack is rarely found. Culturally and morphologically they resemble closely the influenza bacillus and the bacillus described by L. Müller[28] as the cause of trachoma. The latter is now held by the best authorities to be probably an accidental infection, and perhaps a modification of the Koch-Weeks bacillus, which in its turn is closely allied to the influenza organism. The influenza bacillus is also capable of producing a well-marked catarrhal conjunctivitis, which is usually associated with catarrhal conditions of the air passages during epidemics of influenza (zur Nedden,[29] Jundell[30]).

Jundell claims that the Koch-Weeks and influenza bacilli are identical, but Morax,[24] zur Nedden[29] and others who have most carefully studied them, consider that their cultural peculiarities are sufficient to distinguish them, although on a smear they are difficult to differentiate. Like the Koch-Weeks bacillus, the influenza bacillus is very sensitive to drying (Kruse[31]), but the rapid spread of epidemics can hardly be explained unless we accept the drop infection of the air during the coughing and sneezing paroxysms of the affected persons.

2. *Morax-Axenfeld Diplobacillus.*—This was discovered independently by Morax[32] and Axenfeld[33] in 1896,

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[28] Müller: Arch. f. Augenhk., vol. xi, p. 13, 1900.

[29] zur Nedden: Klin. Monats. f. Augenhk., vol. xxxviii, p. 173, January, 1900; also vol. xli, March, 1903.

[30] Jundell: Mitteilungen aus der Augenklinik des Carolinischen med. Chirurg. Instituts, Stockholm, vol. iii, p. 11, 1902.

[31] Kruse: "Die Mikroörganismen," etc., Flügge. Chapter on Bacilli, vol. ii, p. 435.

[32] Morax: Ann. de l'Inst., Pasteur, June, 1896; also Ann. d'Oculist., January, 1897.

[33] Axenfeld: Heidelberger Kongress, 1896, Centbl. f. Bakt., vol. xxi, No. 1, 1897; also Berl. klin., Wochft., 1897, p. 847.

and is now recognized as a widespread and frequent cause of a form of conjunctivitis which is usually subacute, but at times is acute and occasionally complicated with severe ulcerative processes on the cornea. It occurs in large numbers in the secretion, as a large bacillus 1 micron broad and 2 microns long, with rounded ends. The individuals are found in pairs, end to end, sometimes also in chains. It stains readily with ordinary anilin dyes, and is completely decolorized by Gram. Special staining methods have shown that a capsule is probably present, although it is usually invisible by ordinary methods, in contradistinction to the Friedlander's pneumonia bacillus and the ozena bacillus, with which it has often been confused, probably, in examination of the nasal secretion. It can not be cultivated except in the incubator, and usually only on blood serum or serum agar. Blood serum is gradually liquefied, and the media must be alkalin in reaction.

On the conjunctiva the bacilli are present ordinarily in pure culture, sometimes mixed, however, with pneumococci, streptococci or Koch-Weeks bacilli (Hofmann[34]). In culture they are nonmotile, obligate aërobes and rapidly show involution forms. They are nonpathogenic for animals, but unconditionally so for human beings. As they are very sensitive to drying and low temperature, they probably can not be carried by the dust, but they have been demonstrated frequently in the nose (Biard,[17] Erdmann,[20] Axenfeld), and the drop infection must be accepted for them. Erdmann's experiments showed that the organisms retained their vitality after drying of the conjunctival secretion on small linen squares, at room temperature, for fourteen days, and that they could produce conjunctivitis after fifty-four hours, so that infection by means of handkerchiefs and towels must be of frequent occurrence, especially in house epidemics.

3. *The Pneumococcus* (*Fränkel-Weichselbaum*), or *Diplococcus Lanceolatus.*—This is now recognized as one of the most common causes of acute conjunctivitis. It is occasionally found on the normal conjunctiva, but not so commonly as Gasparrini[35] first claimed (80 per cent.). It is only conditionally contagious, some predisposition

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[34] Hofmann: Archiv. f. Ophth., vol xlviii, p. 639, 1899.

[35] Gasparini: Ann. d'Ottalm., vol. xxii, No. 6, 1893.

being required on the patient's side, despite the occasional occurrence of pneumococcus conjunctivitis in epidemic form. It is a frequent cause of conjunctivitis of the new-born, in whom it often causes a blennorrhea, which, however, is not so severe as the gonorrheal form. It has been found occasionally in croupous and diphtheritic pseudo-membranes, alone and mixed with other organisms. On cover glass preparations the diplococci occur in pairs, the individuals being lanceolate in shape, with the flattened ends opposed; chains of four or five members are also found. They are less likely to show capsules in the conjunctival secretion than in sputum and blood. They stain readily and are not decolorized by Gram (being thus differentiated from the meningococcus). They are best cultivated on alkaline media-agar, blood-serum, or blood-agar—at incubator temperature, the colonies appearing as small, transparent, isolated points. The individuals show no capsules in culture, tend to form chains (showing their close relationship to the streptococcus family), and soon lose their virulence.

There is a great variation in pathogenicity between the different types, some being less resistant to drying and exposure than cholera (Germano[12]), while others retain their virulence in a dried state, particularly in secretion, for months. It is especially for this organism that the air infection must be considered, particularly in schools and dormitories (it is the almost constant find among the students in the University of Pennsylvania who develop conjunctivitis), as the organism is so constantly found in the nose and throat, and pneumococcus conjunctivitis is usually associated with rhinitis.

The condition may also arise in an autoinfection, as the diplococcus is a constant parasite in man, either (as in pneumonia,) by increasing the virulence of the organism, or by lowering of the general resistance of the individual, or by local injury to the conjunctival epithelium.

4. *The Gonococcus* (*Neisser*).—This is the cause of gonorrheal conjunctivitis of the adult, and of about 70 per cent. of the cases of ophthalmia neonatorum, the latter being caused also by the Koch-Weeks bacillus, pneumococcus, colon bacillus, influenza bacillus and virulent streptococci and staphylococci, though usually in

a less severe form. The organism is biscuit-shaped, occurs usually in pair between the pus cells, or more often grouped in larger numbers around the nuclei within the cells. It stains readily with anilin dyes, is decolorized by Gram (which differentiates it from the pneumococcus), and is cultivated with some difficulty. The best media are human blood-serum, serum-agar, or a mixture of human blood-serum and bouillon, at temperatures of from 32 to 34 C. The colonies are small, irregular, transparent discs, and the organism rapidly shows involution forms, and usually dies by the ninth day unless reinoculated. It is differentiated from the meningococcus and the pseudogonococcus, described first by Krukenberg[36] by the fact that the latter grow readily on ordinary media. The comparative rarity of these organisms in conjunctivitis makes a confusion with them in the study of a smear probably infrequent, but in case of doubt a culture should be made.

The gonococcus is very slightly resistant to drying or dilution with water, losing its activity in dried secretion after thirty-six hours. It can therefore be transmitted directly, or by soiled articles, or may be carried by flies, as it retains its vitality, according to Welander,[37] as long as the secretion remains moist. It is very contagious but as unilateral cases are not infrequent, and the number of infections of the conjunctiva in adults is small in proportion to the urethral infections, and as Kalt[38] has reported a case in which inoculation of a trachomatous child was unsuccessful, we must consider it less unconditionally contagious than was at one time thought. It may be that the organisms in these cases lose their virulence by dilution or drying in the transfer, or that they are mechanically removed by the tears, or perhaps a certain immunity is established in those who have urethritis.

The gonococcus penetrates rapidly between the cells of the conjunctival epithelium and produces an intense inflammatory reaction. Cases of metastatic infection of

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36. Krukenberg: Klin. Monats. f. Augenhk., vol. xxxvii, p. 271, 1899; also vol. xxxix, p. 604, 1901.

37. Welander: Wien. klin. Runds., No. 52, 1896.

38 Kalt: Soc. de Biol. Séance, Dec. 7, 1895: Ref. in Ann. d'Oculist., vol. cxv., p. 161.

the joints have been reported, especially in new-born children.

5. *Diphtheria Bacillus* (*Klebs-Löffler*).—This organism may be present in the normal conjunctiva, as in the normal pharynx, and is the cause of membranous conjunctivitis, both of the milder croupous and the deeper necrotic form. In the latter it is often associated with staphylococci and streptococci. Pseudomembranes can also be formed by the Koch-Weeks bacillus, by pneumococci, gonococci, staphylococci, streptococci, and more rarely by the meningococcus, Friedländer's pneumobacillus and colon bacillus. These are usually mild forms, but severe necrotic cases have also been reported, in the absence of the Klebs-Löffler bacillus.

It is only moderately contagious to the conjunctiva, requiring certain conditions, especially injury or previous conjunctivitis, and the intensity of the reaction is dependent both on the virulence of the variety and on the resistance of the patient's tissues. It is often found in association with impetigo of the face, and it is quite possible for severe pharyngeal diphtheria to develop from a comparatively mild case of diphtheritic conjunctivitis.

The bacillus is a long rod, straight or curved, one or both ends being clubbed, and staining more deeply than the central segments. No spores are formed. It stains with anilin dyes, is positive to Gram, and grows well on ordinary agar and bouillon, but best on Löffler's blood-serum and serum-agar, in the form of flat, grayish colonies. Involution forms are common.

It must be distinguished from the xerosis bacillus, which is morphologically very similar to it, and as the different types vary greatly in cultures, many authorities consider its virulence to animals the only sure method of differentiation. In the majority of cases, however, Neisser's stain (acetic acid methylene blue for from one to three seconds, followed by Bismarck brown from three to five seconds), applied to the organisms grown on Löffler's blood-serum at 35 C., after from ten to twenty-two hours, shows blue polar staining in the diphtheria bacillus, in contrast to the general brown stain on the rest of the organism. The xerosis bacillus does not show

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39. Knapp: Trans. Amer. Ophth. Soc., vol. x, No. 2, p. 283.

this characteristic staining, or else much later. In alkalin bouillon the diphtheria bacillus produces an acid reaction, the xerosis bacillus never.

According to Arnold Knapp,[39] the diphtheria bacillus causes a media containing dextrin to turn red and to coagulate, while saccharose is unchanged; whereas, the xerosis bacillus produces fermentation with acid production in saccharose, while dextrin remains unaltered.

Identical with the xerosis bacillus is probably also Gelpcke's[40] *Bacillus septatus,* which he described as the cause of "Schwellungskatarrh." The diphtheria bacillus is one of the most resistant to drying (up to six months), and can be carried by the dust, provided the air current be sufficiently strong (Germano[12]). It may be readily transmitted by-drop infection.

6. *Staphylococci.*—These are found frequently on the normal conjunctiva; they are present alone in virulent form in some of the non-gonorrheal forms of conjunctivitis neonatorum, and in pseudomembranous conjunctivitis, either alone or in association with streptococci and diphtheria bacilli.

According to Gonin,[41] they may be considered as the cause of these conditions if present in large numbers and in a virulent form. Ordinarily they are not pathogenic for the conjunctiva, however, and do not produce epidemics. All attempts at inoculation in the human conjunctiva so far have failed. They probably have no causal relationship with phlyctenular conjunctivitis.

The only variety which can be considered pathogenic is the *S. pyogenes aureus,* which is a spherical coccus, found in clusters in the secretion, which stains deeply by ordinary dyes, and is positive to Gram. It grows at room temperature and in the incubator, on all ordinary media, producing abundant yellowish colonies, and liquefies gelatin. It produces an acid reaction in the various media and coagulates milk. It has great vitality, withstanding drying for months, and may be readily carried by dust, thus infecting the air. Römer[42] succeeded in inoculating rabbit's conjunctiva with it, after irritating the membrane with dust or sand. Poulard[43] has recently described 8 cases of acute staphylococcus conjunctivitis following hordeolum, in which the pre-auricular glands were swollen and tender.

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[40] Gelpcke: "Bacillus septatus," Karlsruhe, 1898.

[41] Gonin: Revue méd. de la Suisse Romande, February and March, 1899.

[42] Römer: Zeits. f. Hyg., vol. xxxii, No. 2.

[43] Poulard: Arch. d'Ophtal, October, 1905.

7. *Streptococci.*—As already stated, streptococcus is the cause of pseudomembranous conjunctivitis, either alone or with the diphtheria bacillus, but is relatively most often described in lacrimal conjunctivitis, in association with dacryocystitis (Parinaud's conjunctivitis). In this there is frequently iritis, without involvement of the cornea, swelling and tenderness of the pre-auricular glands, and some fever.

It has been found rarely on the normal conjunctiva; epidemics of streptococcus conjunctivitis have never been reported, although observations of Vossius[44] would indicate that contact infection is possible. In any case it is only very slightly contagious, except in the presence of injury to the conjunctiva.

The organism is slightly smaller than the staphylococcus, and is found in chains of varying length. It stains with the basic anilin dyes, and is positive to Gram. It grows on ordinary culture media, but less vigorously than staphylococcus and forms small transparent colonies, which remain colorless, and do not tend to coalesce. Gelatin is not liquefied. Like staphylococcus, it is very resistant to drying and can readily infect the air.

*Bacterium coli commune, Bacillus pyocyaneus,* and Friedländer's *Bacillus pneumoniæ* have been occasionally reported on conjunctivitis, but are not of sufficient importance to require detailed mention in the present résumé. The influenza bacillus and Müller's trachoma bacillus have been referred to in connection with the Koch-Weeks bacillus. *Meningococcus intracellularis* has been reported several times, and its differentiation from the gonococcus and pneumococcus has been given above, but our knowledge of the organism is still too uncertain to be positive about its pathogenicity. Raehlmann[45] has reported ultramicroscopic organisms in connection with his studies of trachoma, but these results, with his discoveries of similar ultramicroscopic bacteria in sympathetic ophthalmia,[46] require confirmation. We must still consider the organism of trachoma as undiscovered.[47]

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[44] Vossius: Deuts. Praxis, vol. iii, No. 22, 1901.

[45] Raehlmann: Beitr. z. Augenhk., vol. lxii, No. 1, 1905.

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[46] Raehlmann: Deuts. med. Wochft., No. 13, 1904.

[47] The complete bibliography will be found in Axenfeld's articles in Lubarsch and Ostertag's "Ergebn. d. path. Anat.," 1894-1900; in Kolle and Wassermann's "Handbuch der Pathogenischen Mikroörganismen," Jena, 1903, article "Spezielle Bakteriologie des Auges," by Axenfeld, and in Saemisch's chapter "Die Krankheiten der Conjunction," in the Graefe-Saemisch Handbuch der Gesamten Augenheilkunde, Leipzig, 1904, vol. v, part 2, div. 1, chapter 4.

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# THE DIPLOBACILLUS OF MORAX-AXENFELD.*

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The Morax-Axenfeld diplobacillus as a pathogenic agent infecting the cornea and conjunctiva is an organism of the highest importance to the ophthalmologist. In America, in all probability, this organism is very widespread geographically and a frequent cause of infection, but it has not been deservedly recognized. Its recognition is of the greatest importance, because against infection with it we have a specific remedy. Owing to these facts, it has been thought wise to emphasize this organism in this symposium.

In justification of the statements made in the foregoing paragraph, it may be well immediately to call attention to the fact that in the 10 cases recorded below (and this experience accords with those of other observers) clinical conditions were caused by this organism varying from the most serious ulcer of the cornea to the most trivial conjunctivitis; indeed, the organism was found in one case in which there were neither objective nor subjective symptoms. There can be no question of the importance of such an organism to the ophthalmologist. That it is widespread geographically in this country is shown by my recent experience, for I have studied bacteriologically a case which Dr. N. M. Black found in his practice in Milwaukee, and of my

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cases one came from the southern part of Illinois. The fact that ten cases of infection by the Morax-Axenfeld bacillus were found in six months in a small clinical material is presumptive evidence that this bacillus is a frequent cause of infection in this country. That the organism has not received the attention in America that it deserves is evident from the scant literature that we have concerning it. This point has lately been emphasized by Gifford,[1] who in his article speaks of the fact that a most experienced American ophthalmo-bacteriologist had recently written to him that he had never seen a culture of this bacillus.

A recent statement by zur Nedden,[2] of Bonn, suggests to me that possibly this is an eminently fitting time to emphasize in America the importance of this organism in the pathology of the eye. This statement was called forth by Paul's[3] report from the Breslau clinic of a series of cases of serious corneal ulcers caused by the diplobacillus. Zur Nedden says that it is not to be doubted that the Morax-Axenfeld organism in some regions causes severe inflammations of the cornea, but that in Bonn he has not seen such complications as a direct result of infection with it. He suggests that possibly the sensitiveness of the cornea for this infective agent is not everywhere the same, and says that possibly this may be explained on the idea that this disease in the Western provinces of Germany has, as a result of its long existence and wide distribution, lost a part of its virulence. In this country the organism certainly finds much virgin soil, and if the suggestion of zur Nedden holds good we can expect the worst results from it. Four of the cases recorded below support zur

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[1] Gifford: The Clinical Importance of the Diplobacillus of Morax-Axenfeld. Ophthalmic Record, 1905, vol. xiv, p. 511.

[2] Zur Nedden: Ueber einige seltene bacteriologische Befunde beim Ulcus serpens. Archiv. für Augenheilkunde, 1905, vol. lii, p. 143.

[3] Paul: Ueber Hornhautulcerationen durch Diplobacillen. Klin. Monatsb. für Augenhk., 1905, vol. xliii, 1 p. 154.

Nedden's idea; one of these cases, as will be seen, was a severe corneal ulcer.

### LESIONS AND TREATMENT.

During the last six months, as has been said, I have found this organism as the pathogenic factor in ten cases. These cases have shown beautifully the clinical possibilities of this organism and the results of proper treatment; in other words, they tell well the clinical story of the diplobacillus; hence they are introduced here. The disease most typical of infection by this germ is a chronic blepharo-conjunctivitis. In this series I have had six such cases and they are recorded first, the atypical cases following:

CASE 1.—Chronic blepharo-conjunctivitis in a young man who said that the condition was of long standing. The condition presented the picture most often found in infection with this organism. The edges of the lids were red and particularly at the outer angles, where the skin below the margin of the lids was also involved, being macerated by the overflowing of tears. There was more or less scaly deposit on the edges of the lids. The palpebral conjunctiva was not much swollen and only slightly hyperemic; the bulbar conjunctiva was not involved. There was slight discharge. The patient was a good deal annoyed by irritation of the lids. He said that other members of his family were similarly affected. The diplobacillus was demonstrated in culture and smears. Treatment with zinc sulphate ¼ per cent., applied three times daily, and unguentum zinci oxidi applied to the lids at night brought about a rapid recovery.

CASE 2.—Chronic conjunctivitis in an elderly man who said that he had had the condition for a long while and had been under the care of a competent oculist without avail. He complained of burning and smarting of the lids and a good deal of discharge in the morning. The condition showed a chronic blepharo-conjunctivitis, with involvement of the edges and skin of the lids, particularly at the outer angle. Smears and cultures showed diplobacilli. Zinc sulphate, ¼ per cent. solution, applied three times daily, cured him promptly.

CASE 3.—An elderly man on the service of Dr. Ralph Hamill at Dunning Asylum, to whom I am indebted for the privilege of recording the case. The man had a chronic conjunctivitis and smears showed Morax-Axenfeld bacilli.

Case 4.—Chronic conjunctivitis in a business man, resident of Chicago, who complained of a slight discharge from his lids in the morning. There was very slight redness of the palpebral conjunctiva, but no involvement of the edges of the lids. As will be explained below, in spite of attempts to make a bacteriologic diagnosis, the presence of diplobacillus was not at first recognized and the patient was treated for two weeks with 5 per cent. solution of protargol, applied twice daily. This did no good and at the end of that time the medicine was changed to 10 per cent. argyrol, applied three times daily, which also did no good. In the meanwhile the patient had been given glasses to correct a slight refractive error. The glasses were of no service. At the first examination the presence of diplobacilli was suspected and three or four smears at different times were examined, but no diplobacilli found. Cultures were also made on Loeffler's blood serum on which Xerosis bacilli grew, but no diplobacilli. The Loeffler's blood serum that I had used was finally found to contain boric acid. On good blood serum the diplobacilli grew immediately and abundantly. The patient was then given zinc solution and in two weeks he was relieved of all eye symptoms.

Case 5.—A small boy with blepharo-conjunctivitis, and who has recently had repeated phlyctenule-like ulcers at the edge of the cornea and one small ulcer in the center of the cornea. Bacteriologic examination showed diplobacilli and staphylococcus aureus; smears from the conjunctival sac show the latter organisms in great abundance. Treatment with zinc sulphate, ¼ per cent., applied three times daily, brought about a rapid recovery.

Case 6.—Acute conjunctivitis in a man aged 37. The patient stated that the conjunctivitis began two days before consulting me. On examination the palpebral conjunctiva was found acutely inflamed and there was abundant muco-purulent discharge. The patient complained greatly of burning and smarting of the conjunctivæ. He said that the lids were stuck together in the morning. Smears and cultures showed the Morax-Axenfeld diplobacillus. In this case pure cultures of the diplobacilli were found.

Case 7.—Acute conjunctivitis in a lady, age 40. This case was the counterpart of the foregoing one, except that Xerosis bacilli were found along with the diplobacillus. Both of these cases recovered promptly under the effect of ¼ per cent. zinc sulphate, applied three times daily.

Case 8.—Acute conjunctivitis was seen at the Cook County Hospital at the request of Dr. Joseph A. Capps, on whose service the patient was entered, and to whom I am indebted for the privilege of recording the case here. The case was thought to be one of gonorrhœal conjunctivitis. There was a rather profuse muco-purulent discharge and the palpebral conjunctiva was quite red and slightly swollen; the ocular conjunctiva was not involved. In smears there were great masses of diplobacilli—no other organisms were present.

Case 9.—Corneal ulcer. The patient, a man 35 years of age, and a native of Kentucky, stated that from unknown cause his eye became sore and began to discharge several days before Thanksgiving day. He neglected it for several days and then applied to a public clinic for care, where they bandage the eye, put in atrophin, and told him that the eye was in a serious condition. On Sunday following Thanksgiving day he was admitted to my service at the Cook County Hospital. There was a bad ulcer of the cornea which involved about 1/3 of its area and extended from below over the papillary region. The ulcer, which extended deeply into the corneal tissue, showed a yellowish necrotic mass with a slightly bulging center. The cornea at the edge of the ulcer was undermined and a semi-opaque zone extended around the top of the ulcer. The upper part of the cornea was clear and a clear zone separated the ulcer from the limbus below, except at the lower inner side. There was hypopyon and iritis, and the iris was adherent to the lens at places—the pupil was semi-dilated from atropin. There was great double engorgement and a slight muco-purulent discharge. There was no disease of the lachrymal sac. A diagnosis was made of ulcus serpens and the pneumococcus was considered as the probable cause. The ulcer was cleansed with sterile boric acid solution, cocain was applied, smears were made, and also cultures on human blood agar. The cultures developed pseudodiphtheria bacilli; the smears showed pseudodiphtheria and diplobacilli. The ulcer was cleansed, the eye was cocainized, and scrapings from the edge of the ulcer made and inoculated on blood serum. These cultures showed pure cultures of Morax-Axenfeld diplobacillus. Proper steps were taken to differentiate the organism from that of Petit. The usual treatment for corneal ulcers was instituted, with the addition of ¼ per cent. solution of zinc sulphate, a few drops applied every three hours. The condition immediately began to improve and the patient was discharged with a fairly good eye.

CASE 10.—In marked contrast to the case of ulcer is the following one: A young lady consulted me, complaining of headache, which was due to a refractive error. In examining her no symptoms referrable to the conjunctivæ or lids existed, and to all appearances the conjunctivæ were normal, but smears and cultures showed the presence of Morax-Axenfeld diplobacilli and pseudodiphtheria bacilli.

As will have been seen from the foregoing cases, the Morax-Axenfeld diplobacillus can run the clinical scale from no symptoms to the most severe corneal ulcer. On the subject of the importance of such an organism no further remarks are necessary.

Until very recently it has been generally thought that this organism possessed only slight tendency to infect the cornea, and that when the cornea was attacked the resulting lesion was not serious. In Axenfeld's[4] article in Kolle and Wassermann's "Handbuch," we find the statement: "The diplobacilli possess only slight tendency to infection of wounds of the bulb corresponding to the rarity and relative inoffensiveness of the keratitis cases" (*relativenen Leichtigkeit der vorkommenden Keratitis fälle*). In marked contrast to this teaching are the recent findings of Paul,[3] Erdmann[5] and Stoewer.[6] Paul reports 26 severe diplobacillus ulcers of the cornea observed in one and one-half years, Erdmann reports 8 cases of severe corneal ulcers, and

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[4] Axenfeld: Specielle Bacteriologie des Auges, Kolle and Wassermann's Handbuch der pathogenen Mikro-organismen. Jena, 1903, vol. iii, p. 489.

[5] Erdmann: Ein Beitrag Zur Kenntnis der Diplobacillengeschwüre der Kornea, nebst Untersuchungen über die Widerstandsfähigkeit der Diplobacillen gegen Austrochnung in Sekreten. Klin. Monatsbl. für Augenhk., 1905, vol. xliii, 1, p. 561.

[6] Stoewer: Ueber das Diplobacillengeschwür der Hornhaut Klin. Monatsbl. für Augenhk., 1905, vol. xliii, 11, p. 142.

Stoewer reports 26 cases; in these three series of cases a good many eyes were lost as a result of corneal ulcers. Realizing the pathogenicity of the organism for the cornea, one idea that presents itself is that the organism should be looked for before any cutting operations are done on the cornea. Another idea that occurs to one is that in cases of acute conjunctivitis, like the cases mentioned above, it may be that an unusually virulent strain of the organism exists or that the patient is unusually susceptible, and that in such cases an injury of the cornea, such as one may receive from a cinder or other foreign body, might be a serious matter, for it might give a point of entrance in the cornea for the organism. In these cases to prevent such possibilities, I believe it would be wise to confine the patient to the house or have him use protecting goggles during the few days that are required to cure the condition.

In emphasizing the importance of the diplobacillus as a factor of danger for the cornea, I would not underestimate its importance as a pathogenic factor for the conjunctiva, for the conjunctivitis, acute and chronic, that it causes is frequently a serious annoyance to patients and they are grateful when relieved. It is a matter of interest that Axenfeld first observed cases of acute conjunctivitis caused by this organism. It is also an interesting fact that Erdmann[5] and Plaut and v. Zelewski[7] have seen cases like my Case 10, where the diplobacillus existed and caused neither objective nor subjective symptoms.

Recurring to the idea quoted above from zur Nedden, it is interesting to recall the case of acute conjunctivitis in the negro (Case 8), in which the clinical diagnosis was made of probable gonorrheal ophthalmia. Possibly the conjunctiva of the negro offers good soil for this organism; bearing on this idea data on the severity of

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7. **Plaut and von Zelewski: Ueber den Keimgehalt der Bindehaut nach der Thranensackexsterpationen. Klin. Monatsbl. für Augenhk., 1901, vol. xxxix, 1, p. 369.**

the lesions caused by this organism in the negroes of America would be of much interest. Probably this is the first case recorded of conjunctivitis caused by this organism in the negro.

As has been said, the recognition of this organism is important from the standpoint of treatment, because we have a specific remedy for it in zinc. The rapid recovery of my cases under the influence of zinc supports the unanimous testimony as to its efficiency in combating this type of infection. Case No. 4 was particularly interesting from the point of view of treatment, in that the patient for weeks used faithfully the silver salts that just now occupy such an important place in the therapeutic armamentarium of the oculist. This case alone brought to my mind the idea that now, when we in America depend so greatly on the organic salts of silver as remedial agents in conjunctival infections, it would be well to point out the fact that we have with us

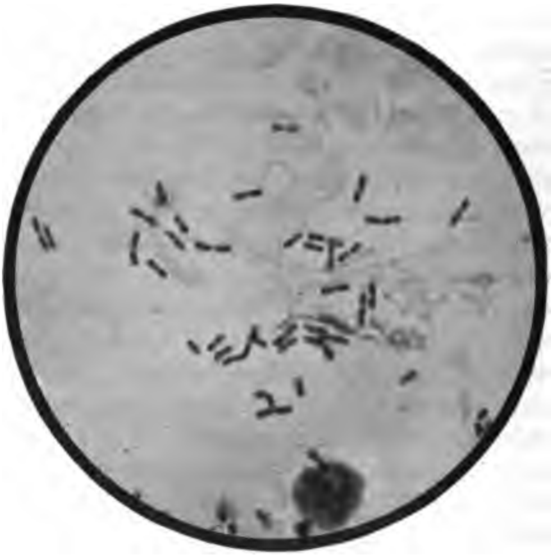

Fig. 1.—Morax-Axenfeld diplobacillus. Smear taken from conjunctiva.

the bacillus of Morax-Axenfeld, and that against infection with this organism these salts have little, if any, effect; at any rate they are not nearly so effective as zinc.

In the case of the ulcer, the zinc seemed to have the best effect. The idea has been suggested that there is danger in the prolonged use of zinc solution in corneal ulcers, because of the possibility of the deposition of zinc in corneal tissue. It is worthy of note that in my case I used zinc sulphate for three weeks, applied every three hours, and then for another three weeks applied three times daily, and that no deposit of zinc in the tissue was apparent.

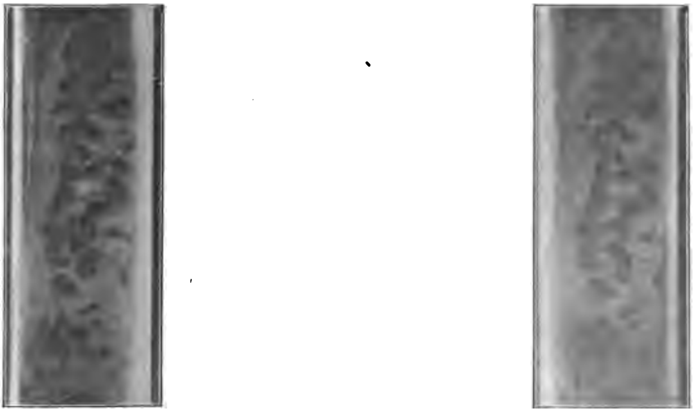

Fig. 2.—Stereoscopic photograph of a culture of the Morax-Axenfeld diplobacillus on blood serum.

CHARACTERISTICS OF THE ORGANISM.

The Morax-Axenfeld diplobacillus, an organism which so far as known is only pathogenic for the human eye, averages about 1 micron wide and 2 microns long, the size, however, varying. When taken from the conjunctival sac the bacilli, in my experience, vary very little in width, the length being more variable as one sees both short and long ones. When grown on Loeffler's blood serum, the medium most often used for their cultivation, one sees great variations in shape and size. Taken from this medium one finds thin bacilli and thick ones, short and long ones and degeneration forms. They usually occur in pairs, end on, whether found in secretion or culture, the ends of the bacilli being slightly rounded. Frequently pairs, dividing into four, as indicated by constrictions forming in the middle of each, are met with. One may also find short chains; this is particularly so in cultures. The bacilli stain with all the ordinary dyes and are negative to Gram.

As a rule, there is not nearly so much secretion in a conjunctival sac infected with this organism as in other forms of conjunctival infection, and sometimes it is hard to obtain a mass for staining, but usually a deposit may be found on the caruncle. From such a deposit generally the bacilli are present in enormous numbers. However, variations from this occur, and sometimes, as in my Case 5, very few organisms are found. The secretion in a diplobacillus conjunctivitis consists in great part of fibrin and is poor in cells. The bacilli may lie on the cells; I have not seen bacilli within cells.

The diplobacillus can be grown only at blood temperatüre, and with certainty only on blood serum or serum agar or on culture media containing human body fluids. Loeffler's blood serum is a most excellent culture medium, and it is a medium which is always available, for almost every city health department supplies it for the diagnosis of diphtheria. On this medium in 16 to 24 hours the bacilli produce a very characteristic picture, in that they liquefy the medium, forming holes in it, the bases of which are moist and without color. After a while these holes become bigger and may in due course run into one another. If the growth is allowed to continue, the culture medium may be almost completely liquefied. Of all the bacteria observed in the conjunctiva none other grows like the diplobacillus on blood serum, except the bacillus of Petit. This organism is very similar in all its characteristics to the Morax-Axenfeld bacillus, and only by cultural characteristics can it be differentiated from the latter, namely, in growing abundantly on all usual culture media and in liquefying gelatin.

# THE PATHOGENIC BACTERIA OF THE EYE-BALL.*

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This article is not intended to be exhaustive, but is designed to call attention to what has been done in this field as it affects the eyeball.

### MICRO-ORGANISMS AFFECTING THE CORNEA.

The micro-organisms that affect the cornea are:

- Bacterium coli commune.
- Bacillus Koch-Weeks.
- Bacillus Kruger.
- Bacillus Klebs-Loeffler.
- Bacillus of Petit.
- Bacillus of leprosy.
- Bacillus Morax-Axenfeld.
- Bacillus perfringens.
- Bacillus pyocyaneus.
- Bacillus ulceris cornea (Zur Nedden).
- Bacillus tuberculosis.
- Gonococcus.
- Pneumococcus.
- Staphylococcus.
- Streptococcus pyogenes.
- Penicillium glaucum.
- Aspergillus fumigatus.
- Aspergillus flavescens.
- Aspergillus glaucus.
- Aspergillus nigricans.
- Saccharomyces.

*Bacillus Coli Communis.*—De Bernardinis[1] reports a case of ulcer of the cornea with hypopyon due to this micro-organism. The patient, a male, aged 35, was struck in the eye with a whip three days before he appeared at the clinic. There was a large ulcer of the cornea with hypopyon, which went on to perforation. Exenteration of the globe was performed by Professor da Vincentiis on the sixth day after the accident. A careful bacteriologic study was made and the colon bacillus was found to be the pathogenic agent.

Randolph[2] reports a case of panophthalmitis due to the colon bacillus. The patient, a male, aged 6, was struck in the eye with a piece of wire. He was seen twenty-four hours after the injury. There was a perforating wound extending across the lower part of the cornea, accompanied by intense pericorneal injection. The inflammatory condition advanced rapidly and on the fifth day the eye was enucleated. Bacteriologic examination disclosed the presence of the bacterium coli.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

[1] Ann. di otal., vol. xxxiii, p. 5.

[2] Amer. Jour. Med. Sciences, 1893, p. 440.

In the few cases reported in which panophthalmitis was produced by the colon bacillus the bacilli gained entrance through a wound and the progress of the affection was very rapid.

*Koch-Weeks Bacillus.*—Ulcer of the cornea due to this micro-organism is extremely rare, but does occur. It is most common in adults. Children are seldom affected. As a rule it accompanies a severe case of conjunctivitis due to this bacillus and is secondary to the conjunctivitis, but the conjunctivitis may be of a moderately severe type. The ulcer may continue to increase in size after the acute stage of the conjunctivitis has subsided. Morax[3] was the first to describe ulcer of the cornea due to this cause. The ulcer develops in from five to seven days after the onset of the acute conjunctivitis. At first there is a small area of infiltration two or three millimeters in diameter, usually near the limbus. The epithelium and superficial layers become necrotic and a superficial ulcer, nearly circular, with sloping edges and a grayish base, develops. The surrounding corneal tissue is slightly infiltrated with small cells. Iritis and hypopyon as complications are very rare. The diagnosis can be made with certainty only by microscopic examination. Scrapings from the ulcer will show the small bacillus when they are properly stained.

Prognosis: Under proper treatment recovery almost invariably results without great injury to the cornea.

*Unnamed Bacillus Described by Kruger.*—Although it is conceded that the undermined or "serpent" ulcer is produced in the greater number of cases by the pneumococcus, other micro-organisms are also found in some cases which apparently are the causative agents. Kruger[4] describes a straight bacillus with rounded ends, measuring from 0.75 to 1.3 microns in thickness and from 1.75 to 4.5 microns in length, which he obtained from the scrapings in "serpent" ulcer, which caused marked infiltration when injected into the corneal tissue of the rabbit. Serpent ulcer may be produced by the *Staphylococcus pyogenes aureus* and by the streptococcus.[5]

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[3] "Recherches bacteri ologiques sur l'etiologie des conjunctivities aigue." Thèse de Paris, 1894.

[4] Zeits. f. Augen., vol. ix, p. 192.

*Klebs-Loeffler Bacillus.*—The affection of the cornea brought about by this micro-organism is probably always secondary to diphtheritic conjunctivitis, although the question of primary ulcer of the cornea due to the Klebs-Loeffler bacillus has been raised by some observers. It has been shown by experiments[6] that the toxin of the Klebs-Loeffler bacillus is the potent factor in reducing the vitality of the cornea; that the first evidence of a necrotic process is an opalescence or blanching of the cornea, which is followed by a roughness of the surface at some point or ever the entire cornea and then a loss of substance. A slight traumatism favors rapid development of the ulcer. It appears that the streptococcus soon finds entrance and is active in the production of the extensive loss of substance. In a case referred to by Petit[7] the Klebs-Loeffler bacillus was recovered from the conjunctival secretions and the streptococcus from the floor of the ulcer. If mixed infection is common we must conclude that the diphtheria antitoxin has a favorable effect on processes in which the streptococcus is present with the Klebs-Loeffler bacillus, as it is found that the corneal lesion, as well as the conjunctival process, is favorably influenced by hypodermic injections of antitoxin. However, if the streptococci predominate the influence of the antitoxin is almost nullified[8] and the lesion of the cornea advances. Not only does the streptococcus appear to thrive in the presence of the Klebs-Loeffler bacillus, but the staphylococcus is also found in company with that micro-organism in diphtheria of the conjunctiva.

Petit[7] has observed and cultivated a bacillus which he terms the *Diplobacille liquefiant,* which bears some resemblance to the diplobacillus of Morax and Axenfeld. It is smaller, however, and when cultivated in coagulated blood serum causes a much greater liquefaction than is produced by the Morax-Axenfeld diplobacillus. The corneal lesion may be superficial; it may also be deep, with undermined edges. Iritis and hypopyon may develop. Petit reports three cases. A characteristic of the ulcer which he emphasizes is the absence of pain and photophobia so long as the ulcer remains superficial. With the development of hypopyon and iritis pain becomes a prominent symptom.

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[5] **Uhthoff and Axenfeld: Graefe's Archiv., vol. xlii, p. 1.**

[6] **Morax and Elmassien: Ann. de l'Inst. Pasteur, 1892, p. 210.**

[7] **"Recherches cliniques et bacteriologiques," Paris, 1900, p. 114.**

[8] **Gonin: Revue med. de la Suisse Romande, Feb. and March, 1890.**

*Leprosy Bacillus.*—The cornea is frequently invaded by the leprosy bacillus in patients suffering from that disease, the invasion resulting in a sclerosing process in some cases, destruction of the corneal tissue occurring in others. The cornea is always secondarily attacked. There are a number of forms of invasion: (a) Superficial punctate keratitis, characterized by the appearance of small grayish nodules at the margin of the cornea, just beneath the epithelium, accompanied by some infiltration of the adjacent cornea. The nodules spread toward the center. They contain aggregations of lepra bacilli, which are also found in the lymph spaces of the corneal tissue.[9] (b) Deep parenchymatous keratitis, "which is always secondary to anterior uveitis." The infiltration does not tend to clear up and the cornea in the affected part becomes thinner (sclerosed). (c) Leprous nodules (lepromata) develop from the limbus. They do not involve the cornea very deeply and may be confined to the limbus or may cover the entire cornea. They are slightly vascular and may ulcerate at their apices, but this does not often happen. Numerous bacilli are found in the tissues of these nodules and are present in the corneal tissue immediately adjoining. A peculiarity of the invasion by lepra bacilli is the almost entire absence of pain.

*Bacillus of Morax-Axenfeld (Diplobacillus).*—Ulcer of the cornea from the diplobacilli has been observed by many ophthalmologists. The papers by Paul,[10] Erdmann[11] and Stoewar[12] are among the latest. In northern Germany ulcer of the cornea from this cause is relatively common. Of 342 cases of diplobacillus conjunctivitis observed in the University eye clinic of Rostock thirty were complicated by corneal ulcer of greater or less severity. The percentage of corneal ulcer caused by the diplobacillus as reported by Paul is 30 per cent.,

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[9] Borthen und Lie: "Die Lepra des Auges," Leipsic, 1899.

[10] Trans. Ophth. Sekt. d. 79, Deuts. Naturforscher zu Breslau, 1904.

[11] Erdmann: Klin. Monats., May, 1905.

[12] Stoewar: Klin. Monats., Aug., 1905, p. 142.

Stoewar 34 per cent. It is probable that this percentage will not hold in other parts of the world.

The character of the ulcer caused by the diplobacillus varies greatly. It may be a shallow marginal ulcer, central or nearly central and shallow, or deep and exhibiting a tendency to spread, and may be accompanied by hypopyon and iritis, resembling the so-called serpent ulcer. Of the twenty-six cases reported by Paul, nine presented the characteristics of serpent ulcer. All the cases were associated with diplobacillus conjunctivitis.[13] In only one case was there an associated dacryo-cystitis. The bacilli were found most plentifully in the tissue at the bottom or near the bottom of the ulcer, in which location they were very numerous.

*Bacillus Perfringens.*—J. Chaillons[14] reports cases. In each case the eye was slightly wounded by a particle of metal. The progress of the infection was rapid; panophthalmitis developed in forty-eight hours and both eyes were enucleated. The bacillus was found in the pus about the wound, in the anterior chamber and in the vitreous. The uveal tract was the principal seat of the exudation, but the retina was invaded and foci of exudation, which were in reality partially isolated colonies, appeared in the vitreous chamber. Pure cultures were obtained. The bacillus has not been observed in the eye heretofore, but it has been found in otitis, appendicitis and in pulmonary gangrene.

*Bacillus Pyocyaneus.*—Hunke[15] cultivated a bacillus from the margins of a "ring abscess" which proved to be the *Bacillus pyocyaneus.* McNab[17] reports a case of infection of the cornea by this bacillus.

*Patient.*—Female, aged 40.

*History.*—On Aug. 8, 1903, the left eye became irritated and six days later edema of the lids; edema and injection of palpebral and ocular conjunctiva occurred. The conjunctiva was covered by a greenish-colored pus. Almost the entire cornea was the site of an ulcer with deep infiltrated borders; the floor of the ulcer was yellowish-white and covered with pus and débris of corneal tissue. The anterior chamber was almost full of fibrinous, purulent secretion.

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[13] Traumatism as the starting-point of the ulcer was established in 69 per cent. of the cases observed by Paul. It is rare to find diplobacillus conjunctivitis in children: because of this it is not surprising to find that 91 per cent. of the cases of diplobacillus corneal ulcer occurred in individuals above the age of 18 years.

[14] Ann. d'ocul., Aug., 1905.

[15] Zeits. f. Augen., vol. x, No. 5, p. 373.

[16] Klin. Monats. f. Augen., Dec. 23, 1903, p. 65.

[17] Ophth. Rev., 1901, p. 345.

*Bacteriologic Examination.*—Cultivation from the secretion covering the ulcer gave the *Bacillus xerosis* and the *Bacillus pyocyaneus.*

*Operation.*—Saemisch operation was performed August 9. The secretion from the anterior chamber, removed under antiseptic precautions, gave cultures of the *Bacillus pyocyaneus.*

*Postoperative History.*—The bacillus could be cultivated from the secretion from the ulcer until the first of September in spite of treatment. Injections of bouillon cultures into the abdominal wall of a guinea-pig developed abscess. Abscess was found in the spleen on autopsy.

McNab gives a short review of two cases reported by Sattler and one case reported by Biotti. In all, the eyes were lost. A case of keratitis reported by Herbert[17] is also referred to. McNab states that the virulent *Bacillus pyocyaneus* may cause ulcer of the cornea without previous traumatism. The secretion is greenish-yellow, the hypopyon thick and fibrinous. McNab[18] also refers to a case reported by Patterson (Edinburgh) of hypopyon keratitis, the ulcer having the character of the serpent ulcer, from which the *Bacillus pyocyaneus* was cultivated.

*Bacillus Ulceris Corneæ.*—In 1902 zur Nedden[19] published his investigations concerning the superficial marginal ulcer so frequently seen in elderly individuals. According to his observations there occurs quite regularly in this form of ulcer a straight or slightly curved bacillus which measures 0.6 micron in thickness, 0.9 micron in length and has rounded ends. Some of the bacilli are smaller and at times quite long threads are found. Vacuoles are observed in staining. The bacilli are easily colored by the anilin colors; they do not stain by Gram. The bacillus is cultivated on agar plates, the surfaces of which are coated with human blood.

The ulcer presents two forms which are not absolutely sharply differentiated. The first group presents itself as a shallow ulcer, from one to two millimeters from the limbus, measuring 2x1 millimeters, with sharp borders, with slight infiltration of the adjacent corneal tissue. The infiltration occupies the superficial layers of the cornea, the epithelium over the infiltration being slightly irregular and cloudy. The long axis of the ulcer is

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18. Klin. Monats. f. Augen., Dec., 1904, p. 543.
19. Graefe's Arch., vol. liv, No. 1, p. 1.

parallel to the limbus. The ulcer becomes quiescent and heals without doing further damage. In some cases the ulcer extends along the border of the cornea, and it may even advance toward the center of the cornea, but this course is not common.

The second group comprises those cases in which the ulcers are multiple. The small ulcers develop from one to three millimeters from the limbus. They are of various sizes and may encircle the cornea. Some of the ulcers may remain isolated, while others enlarge and coalesce with neighboring ulcers, forming a long, irregular marginal ulcer. They seldom encroach on the center of the cornea. The infiltration of the adjacent parts of the cornea accompanies the ulceration, as in the first group. The ulcer comes to a standstill and healing takes place. The process is almost always superficial. Inoculation experiments were not very satisfactory. Thirty-three cases were tabulated.

In a second article[20] zur Nedden recounts an observation of four years and gives forty-three illustrations of cases, in some of which hypopyon accompanied the ulceration of the cornea. He has confirmed his earlier observations and has named the micro-organism *Bacillus ulceris corneæ*. The author observed some cases which were complicated with diplobacilli, a number accompanied by phlyctenulæ and a few with other conditions, but some twenty cases were not accompanied by conjunctivitis or any other disease due to a pathogenic micro-organism. These cases he considers primary corneal ulcer due to the *Bacillus ulceris corneæ*. The affection is usually monolateral. but at times both eyes are involved. The prognosis is favorable.

*Tubercle Bacillus.*—Tuberculous involvement of the cornea may develop from the sclerocorneal margin as an extension from the sclerotic, or it may develop from the posterior surface of the cornea. In the first instance it is characterized by foci of infiltration, which may produce very slight elevations or nodes, or not affect the surface of the cornea. The small areas of dense infiltration are associated with infiltration of adjacent parts of the cornea, not very dense in character. In cases in which the attack is from the surface, the infiltration is in the anterior layers of the cornea. The epithelium over the infiltrated areas is smooth, except over the dense foci or nodes, where it is often rough. Vascularization of the cornea and pericorneal injection occur, varying in degree in the different parts according to the activity of the process. The small, rough, nodular areas on the cornea, the glazed appearance of the surrounding epithelial surface, and the nodular condition of the sclerotic near the cornea in some of its parts form a picture that will enable the observer to differentiate this form of interstitial keratitis from those due to syphilis. The cornea is a poor culture medium for tubercle bacilli; it is very difficult to find them in the tissue. Their presence in the nodes may be determined by inoculating the anterior chamber of the eye of a rabbit.

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[20] Graefe's Arch., vol. lix, No. 2, p. 360.

A form of invasion which appears primarily as a deposit on the posterior surface of the cornea, as in uveitis, is described by K. Stargardt.[21] The corneal tissue becomes infiltrated, the infiltration extending from the deposits. The cornea does not become so densely infiltrated as in the ordinary syphilitic parênchymatous keratitis and eventually clears up entirely. Stargardt gives briefly the histories of eight cases of uveitis which he considers to be tuberculous in origin. They were accompanied by tubercular invasion of the apices of the lungs. All presented changes on the entire posterior surface of the cornea, which occurred as numerous, very small, circular excrescences (fat drops). Some of the cases were accompanied by small nodules in the iris angle, particularly below, and with what appeared to be spots of exudation in the choroid from ¼ to 1 disc diameter in size, the cases closely resembling cyclitis serosa. The peculiarity of these cases is that all the patients recovered under mercurial inunction, which, in my experience, has but little effect on tuberculous affections, although Stargardt states that good results have been observed in tuberculosis of the peritoneum from this form of treatment.

*Gonococcus.* — Affections of the cornea due to the gonococcus are in the nature of ulcers and familiar to all ophthalmologists. It is not necessary here to describe the ulcer. The onset, which may occur at any time during the progress of the ophthalmia after the first thirty-six hours, is marked by a grayish area with roughening and loss of epithelium. The ulcer is probably always secondary to the conjunctivitis. In the greater number of cases the gonococcus is soon joined by the staphylococcus aureus and the ulcer progresses under the influence of mixed infection.

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[21] Graefe's Arch., vol. lx, No. 3, p. 469.

*Pneumococcus.*—Sattler,[22] experimenting with the pneumococcus, found that when introduced into corneal wounds it produced corneal ulcer and hypopyon. Casparini[23] some years later reported his valuable experiments and observations of the effect of the pneumococcus on the eye. When introduced into the corneal tissue in pure culture the pneumococcus almost invariably produced corneal ulcer and hypopyon. Introduced into the anterior chamber and into the vitreous humor, panophthalmitis invariably followed. Perles' experiments[24] confirmed the results of Casparini.

The corneal lesion most commonly produced by the pneumococcus is the so-called serpent ulcer. This has been the observation of many investigators—Basso,[25] Uhthoff.[5] Basso examined bacteriologically sixty cases of hypopyon keratitis, finding the pneumococcus in nearly all.

Annular abscess of the cornea may develop from the toxins of the pneumococci when the infection is of the uveal tract, as observed by Morax,[26] who observed double metastatic iridochoroiditis with the pneumococcus, the primary focus being the lung. One eye developed abscess of the cornea and the eye was enucleated. No pneumococci were found in the corneal tissue, but many were present in the aqueous. Morax and Fuchs are both of the opinion that ring abscess of the cornea may develop as a result of the presence of the pneumococcus in the anterior chamber.

The toxins developed by the pneumococcus are held to be responsible for the destruction of tissue (Colombo and Ricchi[27]) and the production of hypopyon.

According to Römer[28] the aggressions of the pneumococci play an important rôle in the development of ulcer of the cornea. These substances enable the pneumococci to develop in tissue and the malignancy of the micro-organism is in direct proportion to the ability of the particular stock to develop these substances in the tissues.

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[22] Trans. Ophth. Soc., Heidelberg, 1885, p. 8.
[23] Ann. d. Ottal., vol. xxii, p. 131, 1893.
[24] Virchow's Arch., vol. cxl, p. 209.
[25] Internat. Med. Congress, Rome, 1894, vi.
[26] Ann. d'ocul., vol. cxxxii, p. 409.
[27] Ann. di Ottal., No. 12, 1904.
[28] Ophth. Soc., Heidelberg, 1905.

*Staphylococcus.* — Bacterial affections of the cornea occur most frequently with the *Staphylococcus pyogenes aureus.* The conditon of the tissue must be favorable, otherwise the specific pathologic disturbance will not occur. This is proved by the fact that the *Staphylolococcus pyogenes aureus* is a frequent inhabitant of the conjunctival sac without producing any disturbance whatever. This is also true of the pneumococcus, the streptococcus and the *Bacillus subtilis.* Given a condition of the cornea favorable to the development of the staphylococcus, it only remains to afford a means of entrance. Maceration of the epithelial cells, as occurs in many cases of conjunctivitis, or a slight traumatism removing or disturbing the epithelium surfaces. The most common manifestation of a staphylococcus infection is the phlyctenule. So far as my experience goes the ulcer from staphylococcus infection is usually circular, or if it originates as a result of traumatism it follows the line of the trauma. After operative traumatism the infection from the staphylococcus is more amenable to treatment than that from the other two most frequent infections, namely, the streptococcus and the pneumococcus. Hypopyon keratitis is not a very frequent accompaniment of staphylococcic infection of the cornea; however, extension of the infection to the interior of the eye and the development of a panophthalmitis may occur.

Of seven cases of ring abscess examined, Fuchs[29] found staphylococci in two.

### KERATOMYCOSIS.

The different forms of fungus that are pathognomonic for the cornea are *Penicillium glaucum, Aspergillus fumigatus, Aspergillus flavescens, Aspergillus glaucus* and *Aspergillus nigricans.*

*Penicillium Glaucum.*—The appearance of this microorganism is described by Wicherkiewicz.[30] The eye had been struck by a piece of dirt about three weeks previously. In the center of the cornea was a yellowish-white mass, nearly round, about half the diameter of the cornea and having a slightly elevated, uneven surface. The mass was firm and tough. It was removed with a

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[29] Graefe's Arch., vol. lvi, No. 1, p. 1.
[30] Ophthalmic Year Book, 1904, p. 80.

Graefe knife. On examination it proved to contain *Penicillium glaucum.*

*Aspergillus Fumigatus.*—This affects the cornea more frequently than any other fungus. The characteristic lesion is a nearly circular, well-defined, yellowish-white, opaque area, usually measuring from 2 to 4 mm. in diameter, slightly raised, having a matt or greasy surface, with a leash of blood vessels running in from the limbus. In some of the cases the adjacent cornea is irregularly infiltrated with small cells. Hypopyon may accompany the condition, but is sometimes absent or does not appear until the disease has lasted some time.

*Aspergillus Nigricans.*—This affects the cornea much as does the *Aspergillus fumigatus,* the principal difference being that the infected area is black (Bull).[31]

*Saccharomyces.*—The yeast plant has been mentioned by two authors, Stoewar[31] and Lundsgaard,[32] as having been found in ulcer of the cornea. The ulcers were superficial. In Lundsgaard's case the ulcer resembled dendritic keratitis; hypopyon formed but eventually subsided. The observations have not been sufficiently numerous to permit of any definite conclusion regarding the pathogenic action of this micro-organism in the production of ulcer of the cornea.

### RESISTANCE OF THE TISSUES.

*Sclerotic.*—The sclerotic possesses great resistance to invasion by micro-organisms. Ulcer of the sclerotic rarely occurs. In cases of panophthalmitis due to metastasis, or when there is no other adequate opening in the fibrous coat, perforation by infiltration and destruction of tissue takes place through the sclerotic, either along the openings for the ciliary vessels or at the equator along the channels for the passage of the venæ vorticosæ.

Tubercle Bacillus: The tubercle bacillus invades the sclera secondarily to tuberculosis of the choroid and ciliary body. Entering along the canals for the passage of nerve trunks or blood vessels, the tuberculous tissue penetrates between the connective-tissue bundles of the sclerotic, produces ectasia of that membrane and finds its way to the exterior of the globe. On section of such a tuberculous mass the fibers of the sclerotic are found separated, but apparently only partly destroyed.

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[31] Trans. Twelfth, Inter. Med. Cong., Moscow, vol. vi, p. 13.

[31] Amer. Med., July 6, 1901.

[32] Klin. Monats. f. Augen., January, 1900, p. 13.

When tubercle bacilli invade the ocular conjunctiva and subconjunctival tissue they may also invade the episcleral tissue. The process is always superficial and does not as a rule extend to the interior of the eye.

Lepra Bacillus: The bacillus of leprosy may invade the sclera as an extension of leprosy from the ocular conjunctiva at the limbus. Nodules occur of the character described as occurring on the cornea. The denseness of the sclera impedes the progress of the bacilli, but they develop along the channels for the passage of the blood vessels and along the interlamellar lymph spaces. Rows of the bacilli are found with little infiltration of leucocytes. Slow destruction of the tissue of the sclerotic takes place.

### GENERAL INFECTION OF GLOBE.

General bacterial infection of the globe may take place directly, as by traumatism or by perforating ulcer, or indirectly, as by metastasis, producing a general inflammation of all the structures of the eye except the lens.

Other Micro-organisms: The principal micro-organisms that have produced such a general inflammation by direct infection are: *Staphylococcus pyogenes aureus, Streptococcus pyogenes, pneumococcus, Bacillus subtilis, Aspergillus fumigatus, Bacillus coli communis, Bacillus perfringens.*

Panophthalmitis due to the *Streptococcus pyogenes,* the staphylococcus and the pneumococcus, has been studied by many observers. It is well known that destruction of the globe by these germs may occur through extension from corneal ulcer, introduction through penetrating wounds and by invasion of the eye after operations which pierce the fibrous coat either through cornea or sclera. The destructive process develops much the same in all, except that the severity of the inflammation is apt to be much greater when the streptococcus is the organism concerned than when the other two are responsible.

The *Bacillus tubtilis* is rarely the cause of panophthalmitis. Silverschmidt[33] reports two cases:

**CASE 1.—The patient, a man aged 20, was struck in the eye by a fragment of stone May 31, 1900, at 4 p. m. On the following day he presented himself at the clinic. At this time**

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[33] Ann. de l'Inst. Pasteur, April 25, 1903.

the panophthalmitis was so far advanced that all hope of saving the eye was abandoned.

CASE 2.—The patient, a woman, aged 30, was injured by a piece of iron from a mattock, Sept. 25, 1905. She presented herself at the clinic of Professor Haab, who removed the piece of iron at noon September 26. Panophthalmitis had commenced. A rod of iodoform was introduced into the globe, but the panophthalmitis advanced, and on September 27 exenteration was performed. An extensive bacteriologic examination was made in both cases, with the result of proving the inflammation to be due to the *Bacillus subtilis.*

The microscopic examination of a series of eyes that had been removed for panophthalmitis in Professor Haab's clinic disclosed the presence of a similar bacillus in six. A case reported by Kayser[34] is referred to.

The *Bacterium coli commune* and the *Bacillus perfringens* are reported to have produced panophthalmitis by extension from corneal ulcer. These micro-organisms are seldom met.

A few cases of infection of the vitreous humor and deep tissues of the eyeball with aspergillus fumigatus have been reported. Römer[35] reports the case of a boy who cut his eye with a breadknife, causing a penetrating wound in cornea and sclera about 6 mm. long. The patient was seen at the clinic on the same day and the wound was properly dressed. There was very slight reaction. On the ninth day the wound was healed, but there was some ciliary injection in the vicinity of the wound. Some pain was experienced after this. On the thirteenth day there was hypopyon. On the fourteenth day the eye was enucleated. The globe was opened under antiseptic precautions. In the vitreous chamber near the anterior portion a number of yellowish, purulent foci were found. In smear preparations small, oval, highly refractive bodies were found, resembling spores. Cultures were made, showing a growth of the aspergillus fumigatus. The pathogenesis was established by inoculating the cornea and vitreous of a rabbit.

Leber,[36] Nobbe[37] and Kampberstein[38] report a case each. In all the cases the aspergillus was carried into the eye as the result of a penetrating wound.

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[34] Centrlb. f. Bakt., vol. xxxiii, p. 241, 1903.
[35] Klin. Monats. f. Augen., April, 1902, p. 331.
[36] Heidelberger Kongress, 1897.
[37] Graefe's Arch., 1898, vol. xlv, p. 700.
[38] Klin. Monats. f. Augen., February, 1903.

### METASTATIC INFECTION OF GLOBE.

The micro-organisms that affect various parts of the *globe* by metastasis are: Actinomycosis, pneumococcus, staphylococcus, streptococcus, tubercle bacillus, typhoid bacillus and *Micrococcus intracellularis meningitidis*.

*Actinomycosis.*—In an article by L. Muller[39] a case is reported purporting to be one of disseminated actinomycosis of the retina:

**_Patient._—A male, aged 22, entered the hospital with a possible diagnosis of miliary tuberculosis. In the fundus of the right eye a yellowish-white nodule one-fourth of the diameter of the papilla was observed lying near the papilla above and to the nasal side. It was surrounded by a faint pigment ring. Eleven days later the yellowish nodule had increased in size and four more similar nodules had appeared, their diameter being about that af a large papilla. Three smaller but similar nodules had appeared in the retina of the left eye. Eight days later the picture was not materially changed. A diagnosis of tubercular choroiditis was made. The patient died one month after entering the hospital.**

**_Postmortem._—This disclosed disseminated actinomycosis. The posterior halves of the globes were obtained, hardened in formalin and examined microscopically. No definite actinomycosis plant was found, but the microscopic structure of the nodules was such that no doubt was left in the minds of the author that the nodules were the result of the metastasis of actinomyces to the retina.**

There is no well-authenticated case in literature and in consequence it is only possible to say that the occurrence of metastatic actinomycosis is probable.

Frankel[40] saw around the macula lutea of both eyes five or six whitish, round spots, about one-third disc diameter, which resembled miliary tubercles of the choroid. These spots disappeared in about six weeks. The vision was impaired, the defect in the fields of vision being an irregular scotoma. The defect in vision lasted about a year. Frankel believed that the process was due to minute emboli of micro-organisms, probably the pneumococcus.

*Pneumococcus* (*Micrococcus Lanceolatus*).—Metastases of the pneumococcus may occur in cases of nonperforating injury to the eye which reduces the resisting power of the tissues to the influence of micro-organisms that may be circulating in the blood, even when no focus of infection is discoverable. It is well known that this micro-organism is found in the buccal cavity in 20 per cent. of normal individuals, and it is not improbable that a mild degree of pneumococcemia may exist. In a case which I[41] reported three years ago there was an indefinite history of a blow on the eye, without perforation, two days before the loss of vision and commencing inflammation were noticed. Three days later the eye presented the appearance of intense metastatic choroiditis. Evisceration was performed. Examination of the contents of the globe, which were purulent, disclosed a coccus, with capsule, in smear preparations and in cultivation, which proved to be the *Pneumococcus micrococcus lanceolatus.*

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[39] Klin. Monats. f. Augen., March 28, 1903, p. 236.
[40] Arch. d. Ophth., vol. xlviii, p. 456-458.

Metastatic infection of the globe from this micro-organism is most frequent in cases of pneumonia and in pneumococcic meningitis. On March 9, 1906, I saw a patient, a man, aged 58, who was recovering from double lobar pneumonia, from which he had been suffering for three weeks. Three days previously the left eye became painful, vision was lost, the pain increased, chemosis and swelling of the lids developed, with increased lachrymation. When seen there was a yellow reflex from the interior; anterior chamber and lens fairly clear; pupil a little larger than normal; iris dull and slightly swollen. The diagnosis of metastatic choroiditis, probably from the pneumococcus, was made.

Both eyes are sometimes affected.

*Staphylococcus.*—Liebrecht[42] reports a case of metastatic choroiditis caused by the staphylococcus:

*Patient.*—A young man, became ill six days before entering the hospital. His mother said that a furuncle on the forehead was the first manifestation. When seen there was swelling of the left side of the forehead and a small wound from which pus was squeezed. The pus contained staphylococci. There was severe staphylococcemia. The right pupil was dilated. The patient died shortly after entering the hospital.

*Autopsy.*—The posterior halves of both eyes were removed. Small hemorrhages were present in the retina of each eye. The choroid was studded with small, white circular nodules.

Microscopically, the retinæ were normal except for the hemorrhages. The choroid was normal except at and in the vicinity of the white nodules. These were miniature abscesses. In the middle of each small abscess a mass of staphyl-

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[41] Ophth. Rec., February, 1903, p. 61.

[42] Klin. Monats. d. Augen., Sept. 3, 1903, p. 127.

**ococci was found, lying close beneath the lamina elastica. The abscesses were irregularly distributed.**

*Streptococcus.*—A case of streptococcus metastasis is also reported by Liebrecht:[42]

***Patient.*—A young man became ill six days before entering of the right breast, which was opened and found to contain streptococci. General pyemia developed. On the fourteenth day after the beginning of the illness, the eye became affected, the vision failed, and in twenty-four hours after the first symptoms there were iritis, much chemosis and some exophthalmos—in fact, the picture of beginning panophthalmitis. The symptoms were greater on the following day and the eye was enucleated. On section, pus was found in the vitreous chamber. Streptococci were found in the vitreous chamber, in the retinal tissue and subretinal tissue. The metastasis had undoubtedly taken place in the small vessels in the temporal half of the retina. The patient recovered. There was no streptococcemia.**

Metastatic panophthalmitis may occur by the transfer of the staphylococcus or streptococcus through the blood current to the choroid and retina from any part of the body where a pathologic process due to either of these micro-organisms is taking place. I have observed it accompanying ulcer of the vagina, furuncle of the forehead, empyema and abscess of the leg. Acute endocarditis may cause isolated hemorrhages in choroid or retina or may cause a panophthalmitis, the starting point of which may be choroid or retina.

*Tubercle Bacillus.*—When tubercle bacilli infect the interior of the eye they almost invariably develop in the vascular tunic, namely, choroid, ciliary body and iris. The development is in three forms: First, as miliary tuberculosis, in which small, circular, pale-yellowish spots appear in the tissues; second, diffuse tuberculosis, that of tuberculous inflammation affecting the entire uveal tract to a greater or less extent and being accompanied by disturbing evidences of inflammation, and, third, conglomerate tubercle, which develops as an intraocular tumor, being often difficult to differentiate from sarcoma of the choroid and glioma retinæ.

Miliary tuberculosis of the choroid is the most common form. In general miliary tuberculosis it occurs, according to Bock,[43] in 82.7 per cent. of the cases; others put the percentage much lower. The tubercles vary in size from a pin-point to 2 mm.;

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[43] Virchow's Arch., vol. xci.

they are seldom larger. A tuberculous patch 2 mm. in size is usually made up of a number of nodules. The tubercles may be very few in number or they may be very numerous. They occur most commonly in the vicinity of the disc, but may be scattered over the entire fundus; they are very slightly raised, usually without a pigmented ring, causing no symptoms of inflammation and interfering but little with vision, the condition presenting to some extent the appearance of the exudative stage of disseminated choroiditis. The tubercles spring either from the chorio-capillaris or from the layer of large vessels, the former site being the more common. Since it often happens that a blood vessel is found in the center of a miliary tubercle, it is thought that the infection is through the medium of the blood vessels, but the lymph spaces are also credited with being avenues of extension. The tubercles form quite rapidly, appearing within twenty-four hours; they are, of course, most common and numerous immediately before the death of the patient.

The tubercle may project forward into the retina or posteriorly into the lamina fusca. The tubercle bacilli, according to Parsons,[44] are present in greatest number in the caseous area. (I have found them to be most plentiful at the periphery of the caseous area.) They may be very numerous, but as a rule are not present in large numbers.

Diffuse tuberculosis of the choroid is next in frequency. It develops as a succession of indifferent miliary tubercles, which may extend into and involve the retina and sclera, and the condition may present the appearance of pseudoglioma, or even of plastic choroiditis.

The solitary or conglomerate tubercle is uncommon. Resolution may take place, leaving a cicatrix, but the usual course is progression and perforation.

It sometimes occurs that secondary tuberculous nodules develop in the papilla and retina. Such a case is reported by Stock.[45]

Tubercle of the choroid is secondary to general tuberculosis or tubercular foci in other parts of the body in almost all cases, but cases of solitary or conglomerate tubercle of the choroid have been observed (zur Nedden[46]) in which other foci could not be determined. In spite of this, we are not at present in position to state that tuberculosis of the choroid is ever a primary manifestation.

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[44] "Pathology of the Eye," p. 464.
[45] Münch. med. Wochft., June, 1902.
[46] Klin. Monats. f. Augen., Oct. 13, 1903, p. 354.

*Typhoid Bacillus.*—I am not aware that the typhoid bacillus has been recovered from the globe at any time, but a few cases of metastatic panophthalmitis during typhoid fever have been reported. Gilfillin[47] reports such a case in which the metastasis occurred on the twenty-sixth day of the attack of typhoid in an eye previously blind. Rupture of the globe and the escape of pus were followed by healing, resulting in a deformed globe.

Retinal hemorrhage accompanying typhoid has been observed not infrequently. What rôle, if any, the bacilli have in these disturbances is not known.

The question of the influence of toxins, especially the toxins of the typhoid bacillus, is considered by Gaspanini,[48] who is of the opinion that changes in the vessel walls and exudation and hemorrhage are in many cases due to the presence of the toxins in the blood, the bacilli being absent. In discussing this statement Bietti[49] states that the fact that the bacilli have not been found in these cases does not prove that they were not present at the beginning of the process, as they may have been present and have disappeared, since the examination of the tissue was not made until the process was two or three weeks old.

Metastatic processes may first affect the iris as Michel[50] has shown, a metastatic streptococcus infection having occurred in the circulus arteriosus iridis major, and the same may occur in the ciliary body, as in the case reported by Römer,[51] in which the beginning of the process was due to a pneumococcus embolus in the ciliary body.

Axenfeld was one of the first to point out the fact that in metastatic ophthalmia the retina is often the part first affected. His investigations led him to believe that this was the condition in about one-third of the cases. It may happen, as shown by Axenfeld and Goh[52] that in double-sided metastasis the choroid may be primarily affected in one eye, the retina in the other.

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[47] Medical News, July, 1903, p. 165.
[48] Ann. di Ottal., vol. xxiv, 1895.
[49] Klin. Monats. f. Augen., vol. xli, p. 72.
[50] Zeits. f. Augen., vol. vii, 1902, p. 1.
[51] Klin. Monats. f. Augen., 1902, p. 320.
[52] Arch. f. Augen., vol. xliii, 1897.

Winterstein[53] found the *Micrococcus intracellularis* in the uveal tract in a case of metastatic ophthalmia.

### IRIS.

The principal micro-organisms that affect the iris are: Bacillus of leprosy, bacillus of tuberculosis, gonococcus, pneumococcus, staphylococcus and streptococcus.

Infection of the iris by the staphylococcus, streptococcus or pneumococcus may take place as a result of extension from corneal ulcer, introduction through perforating wounds, by extension from the deeper parts of the eye, as in panophthalmitis, beginning back of the iris, and by metastasis directly affecting the iris. A purulent process is the result of infection by these micro-organisms.

*Leprosy Bacillus.*—When the leprous bacilli infect the iris it is by extension from the ciliary body. The iris is invaded by the bacilli and by leucocytes and becomes enormously thickened. Isolated nodules are said not to occur. The condition is associated with manifestations of leprosy in other parts of the head.

*Gonococcus.*—Iritis as an accompaniment and probably a result of gonorrhea, has been observed by many ophthalmologists. The recurrent nature of this form of iritis is well known. Fresh attacks of urethral gonorrhea and gonorrheal rheumatism are followed by recurrence of the iritis. Although the probable causative relation is recognized, no cases, so far as I am aware, have been reported of the recovery of the gonococcus from the aqueous humor or from the iris. It is supposed, as set forth in the article by Cheatham,[54] that the attacks are excited by the ptomains or toxins generated by the gonococcus rather than by the presence of the micro-organism itself.

*Tubercle Bacillus.*—Tuberculosis of the iris occurs in three distinct forms:

1. Miliary tubercle, characterized by the appearance of a number of small yellowish-white nodules which may appear in any part of the iris, and cause slight thickening and an increase of vascularity of the iris in the part affected, accompanied by a very slight plastic

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[53] Gruvert. Ueber Ret. Optica und Metastatica. Heidelberger Kongress, 1902.

[54] Arch. of Ophth., vol. xxv, No. 4.

exudation which aids in the development of posterior synechiæ. Vision is impaired and serious injury to the globe may follow, but a very benign course may be run, the tubercles disappearing spontaneously. Children and young adults may present this form of tuberculosis of the iris.

2. Conglomerate tubercle, characterized by the development of a single tubercular mass, usually springing from the major zone of the iris, and projecting into the anterior chamber. Small isolated tubercular masses may also be present. The mass, pale in color, is only slightly vascular at its base and produces but little inflammatory reaction in the iris. The tendency is to increase in size quite rapidly, to fill the anterior chamber, to become disseminated, to perforate and to cause destruction of the globe.

3. General diffuse tubercular infection of the iris is a rare manifestation. It is characterized by a general thickening of the iris tissue without definite tubercular masses, and is accompanied by a flocculent exudation which may almost fill the anterior chamber. The condition advances slowly; necrosis takes place after considerable time has elapsed from the onset of the affection.

The diagnosis of tubercular iritis may be made by eliminating syphilis and iritis nodosa by the tuberculin reaction, by the discovery of the tubercle bacillus in the affected tissue, and by the inoculation of the anterior chamber of the eye of the rabbit with bits of infected iris tissue, and, possibly, by exudation taken from the anterior chamber of the affected eye. Tubercular iritis is usually monolateral. The question of the occurrence of tuberculosis primarily in the iris has been discussed *pro* and *con* by many writers. The weight of evidence appears to be in favor of its being primary in some cases, at least.[55]

*Other Micro-organisms.*—The extension of inflammatory processes primarily affecting the cornea due to the *Bacterium coli commune,* Klebs-Loeffler, Morax-Axenfeld, *Bacillus perfringens, Bacillus pyogenes* and *Bacillus subtilis* may lead to bacterial invasion of the iris, but this forms only a part of the general invasion of the globe.

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[55] Denig: A. f. D., vol. xxxi, 1895.

### VITREOUS.

Primary infection of the vitreous with micro-organisms is extremely rare, if it ever occurs. The invasion of the vitreous with inflammatory products and with micro-organisms is secondary to inflammation extending from other tissues of the eye or to their introduction by penetrating wounds.

### LENS.

I have demonstrated the presence of the staphylococcus in the tissues of the lens with small-cell infiltration following a penetrating wound of that body, but invasion with micro-organisms in any other way probably does not occur.

### RETINA.

The infection of the retina with micro-organisms has been termed exogenous when it occurs from injury or by the extension to bacterial invasion from neighboring tissues or from the vitreous or uveal tract; and endogenous or metastatic when the infection takes place from the blood vessels or lymph channels or the perivascular lymph spaces.

*Exogenous Infection.*—The retina may be invaded by any of the micro-organisms that grow and produce pathogenic or pyogenic processes in the other tissues of the eyeball. Micro-organisms carried into the eye by penetrating foreign bodies seldom produce an inflammatory process that is confined to the retina.

*Tubercle Bacillus.*—The invasion of the retina by the tubercle bacillus is almost always secondary to tuberculosis of the optic nerve or of the uveal tract, and is, in the greater number of cases, exogenous, but in some cases reported the development was apparently due to endogenous infection.

*Endogenous (Metastatic) Infection.*—It is now well-known that metastatic panophthalmitis due to the streptococcus, staphylococcus, Liebrecht,[56] and possibly the pneumococcus may originate by the transfer of the micro-organism from some focus in the body to the retina by means of the blood-current. Infections of less severity undoubtedly occur in cases of bacteriemia. In the retinitis septica of Roth, which now includes a number of conditions, the metastatic transfer of micro-organisms from outside foci to the retina plays a part in some of the cases. Frankel[40] and Goh[57] have reported cases in which the pneumococcus was the micro-organism. In Goh's case there were white spots and hemorrhages in the retina and on microscopic examination the pneumococcus was found in the exudation, which formed the white spots.

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[56] Klin. Monats. f. Augen.

*Tubercle Bacillus.*—The invasion of the retina with the tubercle bacillus from the optic nerve in cases of tubercle of the optic nerve may be by endogenous infection, the bacilli advancing along the lymph channels, but it is probable that the invasion is simply by way of the tissue of the retina in the manner of exogenous infection. Two cases of tuberculosis of the retina apparently primary and due to endogenous infection, have been reported; one by O'Sullivan and Story,[58] a second by Hancock.[59] In both the histologic appearance was one of tubercle, but no tubercle bacilli were demonstrated.

*Actinomycosis.*—As a metastatic infection of the retina, actinomycosis has been described by L. Muller.[30] Although the elements of the fungus were not found in the nodules that developed, the anatomic findings were such that the correctness of the diagnosis could scarcely be doubted.

*Leprosy.*—When the bacillus invades the ciliary body and choroid it may also pass into the retina. However, the retina is seldom involved in leprosy and when it is the disturbance is slight. The degree of the invasion is discussed by Borthen and Lie,[9] Frank and Delbanco.[60]

### METASTATIC OPTIC NEURITIS.

In the opinion of Parsons,[61] metastatic optic neuritis occurs much more commonly than the recorded cases would lead one to expect. Parsons refers to four reported cases, two by V. Michel,[62] and two by Axenfeld.[33] Michel's first case occurred in a man with epididymitis and endocarditis. The optic papillæ were hyperemic and there were some small venous hemorrhages in the retina. Small foci of infiltration were found in the orbital portion of each optic nerve. No micro-organisms were

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57. Arch. f. Ophth., vol. xliii, 1, 1897.
58. Trans. R. A. of Med. of Ireland, vol. xvii, 1899.
59. Royal Lond. Ophth. Hosp. Reports, vol. xvi, p. 2, 1905.
60. Arch. f. Ophth., vol. l, p. 2, 1900.
61. "Pathology of the Eye," vol. ii, p. 682.
62. Zeitschr. f. Augen., vol. vii, 1902.
63. Arch. f. Ophth., vol. xl, p. 3, 1894.

demonstrated. The second case occurred in a man with pyemia, who had metastatic iridocyclitis. There were three miliary abscesses in the left optic nerve, one in the dura. These abscesses contained micrococci in their centers. Axenfeld's first case was one of pneumococcic metastasis occurring in a child of two months. The second case was that of a child of ten days in which the infection was with streptococci.

Parsons remarks that "it is possible that optic neuritis following infectious diseases is not due to embolism, but to toxins." This would apply to post-diphtheritic papillitis, of which I have seen a number of cases. Recovery is complete in these cases.

*Tubercle Bacillus.*—The optic nerve may be invaded by tubercle bacilli as an extension from the brain, Sattler,[64] as an extension from the choroid and from the orbit, Spaulding,[65] and by the bacilli in miliary tubercles, undoubtedly metastatic, in connection with miliary tuberculosis.

*Development in the Nerve Itself without Known Foci Elsewhere.*—In Spalding's first case the tubercular mass developed in the optic nerve and projected into the vitreous chamber, filling one-third of it. The growth occurred in a boy of eight years and followed traumatism. The patient remained free from other manifestations of tuberculosis. A. Knapp[66] reports a similar case to that of Spalding. The bacteriologic examination was positive for tubercle bacilli. The patient, a negro child of two years, subsequently developed general tuberculosis.

Leprosy bacilli have been demonstrated in the optic nerve, Borthen and Lie,[9] but observations of this nature are extremely rare.

In the consideration of this subject syphilis has been purposely omitted.

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[64] Arch. f. Ophth., vol. xxiv, 3, 1878.
[65] Trans. Amer. Ophth. Soc., 1903, p. 141.
[66] Arch. of Ophth., vol. xxxii, No. 1, p. 22.

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# THE STAINING AND EXAMINATION OF THE BACTERIA OF THE EYE BY SIMPLE PRACTICAL METHODS.*

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The staining of the bacteria of the eye with a view to the practical benefits to be derived therefrom may be conveniently divided as follows: Film preparations, including both smears from fresh conjunctival discharge and culture preparations; scrapings from corneal or conjunctival ulcers; tissue preparations.

Film preparations from the fresh conjunctival discharge, which represent the greater proportion of our work at present in the Laboratory of the Manhattan Eye, Ear, and Throat Hospital, are of value not only in arriving at a correct diagnosis, but also in the study of the progress of the disease. Every case which is admitted to the contagious wards has several films made, followed by cultures if this latter seems necessary; and thereafter, as long as the patient remains in the hospital, film preparations are made every two or three days. In preparing the films some care is necessary in order to secure the best results. After thoroughly cleansing the slides in alcohol, a small amount of pus from the conjunctival cul-de-sac is taken up on a platinum wire loop and spread as thinly as possible on the slides. In doing this, the drop should be led gently over the slide rather than rubbed on, for if too much violence is used the relations of the cells and bacteria may be disturbed. The practice of taking the pus on a cotton swab and rubbing it over the slide is a very bad one and likely—in the case of gonococcus at least—to lead to erroneous results. The slides are then dried and are ready for staining.

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For general work, Loeffler's methylene blue continues to be our most useful stain. It is made by adding 30 parts of concentrated alcohol solution of methylene blue to 100 parts of 1 to 10,000 aqueous solution of caustic potash. This solution is poured over the slide and rocked back and forth until the smear is colored a fairly deep blue, generally in from a few sectonds to a minute. The slide is then washed freely and dried, when it is ready for examination with the oil immersion lens. No cover-glass is necessary; the drop of oil is placed directly on the slide. The pus and epithelial nuclei are stained deep blue, the cytoplasm and mucus faintly, while the majority of the bacteria are stained to about the same intensity as the pus nuclei. Carbol fuchsin in 5 per cent. solution may be used in the same way, but it offers no especial advantages in the majority of cases over the methylene blue, so in practice we do not often use it.

Counter-staining is of distinct advantage in showing certain details not ordinarily visible; the cytoplasm shows more plainly, the contrast is greater, and there is better cell differentiation, showing the relation of cells to bacteria. Our pathologist, Dr. E. G. Zabriskie, uses Wright's modification of Jenner's blood stain (eosinate of methylene blue), or Goldhorn's polychrome methylene blue. In preparing the eosinate of methylene blue the first step is to precipitate the red in methylene blue by dissolving 1 gm. of methylene blue in a 0.5 per cent. solution of sodium bicarbonate. This mixture is steamed for one hour in an Arnold steam sterilizer, then cooled rapidly, and poured into a large porcelain dish. Under constant stirring, a 1 to 1000 aqueous solution of yellow eosin is then added until a metallic scum appears. About 400 or 500 c.c. of the eosin solution will be found necessary for 100 c.c. of the original methylene blue solution. The precipitate is then collected by filtration, carefully dried by gentle heat, and a saturated solution is made of the precipitate in pure methyl alcohol. About 0.3 per cent. is necessary for saturation. The mixture should then be carefully filtered, and 25 per cent. of methyl alcohol added.

In using the stain no preparatory fixation is required. The stain is applied for one minute, during which fixation takes place through the methyl alcohol. Distilled water should then be added, drop by drop, until a metallic scum forms on top of the liquid and the edges are a purplish red color. The actual staining now takes place, and this is kept up for from 3 to 5 minutes. The slide is then washed and dried and the smear examined.

The washing is a delicate process; on it depends in great part the success of the stain. It must be done very slowly, carefully and thoroughly. The nuclei will be found blue to purple green, the bacteria purplish, and the neutrophilic granules purplish pink. Goldhorn's polychrome methylene blue is used exactly as Loeffler's methylene blue. The stain may be bought already mixed, and the smear is simply stained for one minute or less, washed and dried.

Decolorization is of great value, from a diagnostic standpoint, owing to the fact that different bacteria give up the stain with very different degrees of readiness. It is especially valuable in the case of the gonococcus, and is best accomplished by the method of Gram, which is as follows:

**Fix with gentle heat.**
**Stain with anilin gentian violet three minutes.**
**Wash with salt solution.**
**Add iodin solution for one minute.**
**Wash.**
**Decolorize with absolute alcohol until the smear looks steel-gray.**

The most important germ with which we have to deal from the practical clinical standpoint—both from the severity of its effects and its relative frequency—is the gonococcus. In typical cases, soon after the onset of the disease, we find under the microscope large clusters of perfectly characteristic biscuit-shaped diplococci lying chiefly within the pus and epithelial cells and showing a pale capsule surrounding each pair of individuals. Tetrads are uncommon in the conjunctiva. They stain well with Loeffler's methylene blue or either of the counter-stains above mentioned.

In the great majority of cases, the clusters are perfectly characteristic for the first 5 to 7 days after the onset of the disease, and if the clinical appearances of gonorrheal conjunctivitis are well marked we make no further examination. If, however, the clinical appearances are not characteristic and the smears show many varying forms lying outside of the cells, we next proceed to decolorize by Gram's method. If the bacteria decolorize, we have either the gonococcus or the diplococcus of meningitis, or perhaps the *Micrococcus catarrhalis*. Modern observers almost all agree that staphylococci, though they may assume the form of diplococci, never have the concavities facing each other as in the case of the gonococcus, and the capsule—except in the pneumococcus—is also lacking. It is easy, therefore, to say that a case which has the typical appearance and in which the clinical symptoms are characteristic is gonorrheal; while it is extremely difficult to say that any given case—especially late in the disease—is not gonorrheal. The meningococcus may assume the typical form of the gonococcus, but is rather rare in the conjunctiva and causes a much less severe inflammation. Many diplococci will be found lying outside of the cells and numerous varying forms will be present. If doubt still remains, cultures alone will decide the diagnosis.

As the attack of gonorrheal conjunctivitis yields to treatment, the groups of gonococci grow smaller and show many varying forms (involution forms) of less characteristic shape, but as long as the least amount of discharge remains the germs will be found. Some writers assert that the gonococci may be found even after the discharge subsides. On this point I can not speak from actual experience, but when the pus cells disappear and the discharge assumes the catarrhal form, with mucus predominating, gonococci can not usually be demonstrated, and it is our custom to discharge the patient from the hospital wards.

The diplococcus of meningitis deserves mention, not from the frequency of its occurrence—for all agree that it is rare in the conjunctiva—but on account of its similarity to the gonococcus. It occurs within the polynuclear leucocytes, but, according to Park,[1] "it never appears within the nucleus and rarely within other cells." It is decolorized by Gram, as is the gonococcus, but the cultural differences—into which I will not enter here—are decisive. During about eight years we have seen at the Manhattan Eye, Ear and Throat Hospital only three or four well-established cases to about 400 cases of gonorrheal ophthalmia. Of course, it should be said that the severe cases do not come into the wards, and this would, no doubt, somewhat reduce the number of the meningococcus cases. Parsons[2] says: "The rarity of this organism scarcely vitiates the ordinary rules of procedure, but in cases of doubt cultivation experiments must be resorted to." The *Micrococcus catarrhalis* (R. Pfeiffer) is believed by Park to have been at times confused with the meningococcus, and it is possible, of course, that our cases were caused by this organism. The clinical symptoms were those of a very insignificant conjunctival affection, and a few days' treatment sufficed to clear up the discharge; so that, lacking the peculiar cell penetration that is so characteristic of the gonococcus, it seems fairly certain that they were either meningococci or one of its allied forms, and not the gonococci, and, as this was for us the point of practical importance, I regret to say that no careful culture studies were made. Of course, the clinical condition and history were carefully considered, as they should always be.

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[1] Park: Pathogenic Micro-organisms, p. 361.

[2] "The Pathology of the Eye," vol. 1, p. 44.

Other diplococci occasionally resemble gonococci, but most of them are positive to Gram. In this connection it should be remembered that, on account of the rapid onset and alarming appearance of gonorrheal ophthalmia, such cases usually come under our care early, at a time when the gonococcus is well developed and is most characteristic in smears. Later, when involution forms begin to appear, the diagnosis is more difficult and smears are of less value. Another fact which makes early smear examinations important is that the other pus cocci develop more slowly than the gonococci, and early smears show very few other organisms.

The detection of the Koch-Weeks bacillus in smears is fairly easy. It belongs to the group of influenza bacilli and seems to be the commonest cause of acute contagious conjunctivitis. The clinical characteristics of the disease caused by it vary considerably. It is worse in some epidemics than in others, so that we have little to help us in the clinical symptoms. They appear as short fine rods (0.8 by 10 micromillimeters) lying frequently between the pus cells and also within the cytoplasm in great numbers. They frequently lie end to end in the shape of the letter V. They take the stain with difficulty, and in methylene blue preparations stain usually to about the intensity of the cytoplasm, so that a first glance through the microscope gives only a faint idea of the number usually present. As more careful examination is made the bacilli may be seen by hundreds. They are best stained with Ziehl's solution of carbol fuchsin, 1 part to water 9 parts, or with Loeffler's methylene blue applied with gentle heat.

According to Park, it is to be differentiated from: 1, the influenza bacillus of Pfeiffer; 2, the so-called influenza bacillus of conjunctivitis, of Müller; 3, the pseudo influenza bacillus of Zur Nedden. All these grow only on a hemoglobin medium, which is not required by the Koch-Weeks bacillus. They are nearly allied forms and can not be morphologically differentiated from the Koch-Weeks, but from a practical standpoint the film diagnosis is of considerable value, as the other forms are probably much rarer. In cultures of the Koch-Weeks, club-shaped involution forms commonly appear. It is decolorized by Gram.

The Morax-Axenfeld diplobacillus has quite a characteristic appearance in smears. It causes a low grade of chronic blepharo-conjunctivitis, and occurs plentifully in the conjunctival discharge in such cases. The bacilli are large (2 micromillimeters by 1), though this varies, and they are frequently found in chains. They stain well with ordinary anilin stains and are decolorized by Gram. According to Parsons, the *Bacillus liquefaciens* of Petit is a diplobacillus closely allied to the Morax-Axenfeld. It occurs in corneal ulcerations, especially of the corneal margin, and, as a rule, is smaller than the Morax-Axenfeld. Cultural differences are marked and will establish the diagnosis.

The Klebs-Loeffler bacillus of diphtheria, which occurs very rarely with us in the conjunctiva, is a short thick bacillus which varies considerably in size and virulence, facts which Parsons believes account for many of the so-called pseudo-diphtheria bacilli. There are no differential stains of reliability, and cultures, which are best made in Loeffler's blood serum, are invariably necessary. The cultural forms vary considerably and show a marked beading or polar staining.

The xerosis bacillus of Colomiatti closely resembles the bacillus of diphtheria, both morphologically and culturally. The whole question of differential diagnosis is an involved one. Both bacilli stain readily with the ordinary anilin dyes and are easily cultivated, and, aside from the chemical differences—which have recently been studied a good deal and seem to promise well—the subject seems to resolve itself into the degree of virulence of the individual growth. Within the past eight years we have had but four cases of genuine conjunctival diphtheria in our wards, and in these the severity of the clinical symptoms left no doubt that we were dealing with true diphtheria.

Staphylococci, streptococci and their allied forms deserve only a passing mention in the present connection. They all stain readily with anilin dyes, have no differential stains of value, and must be studied by cultures and inoculations to arrive at a correct bacterial diagnosis.

The pneumococcus of Fränkel and Weichselbaum is of importance, both as regards its rôle in conjunctivitis and in ulcus serpens of the cornea. It frequently has a characteristic shape in smears, and a diagnosis can be made with a fair degree of certainty in many instances, but in other cases the forms vary so greatly that cultures must be made. When typical, it has the shape of two cartridges placed end to end and surrounded by a pale capsule. In many instances this capsule is absent and the lanceolate shape is not marked, and it may even form short chains. As a modern writer puts it: "Its chief characteristic is variability." It is best stained with weak carbol fuchsin, as in the case of the Koch-Weeks. The slide is gently heated during the staining, in which case the capsule, if present, will show clearly.

Scrapings from a conjunctival or a corneal ulcer may frequently give valuable information. If the case is one of suspected tuberculosis of the conjunctiva, it is best, on account of the scanty distribution of the bacilli, to excise a piece of tissue from the margin of the ulcer carefully and to "shred" it in a small amount of normal salt solution, and then to spread the whole on slides which are stained for tubercle bacilli with carbol fuchsin and methylene blue, a method that is so well known as to need no description here. Corneal scrapings should be treated in the same manner and then stained with methylene blue. It is not, however, always possible to find the distinctive germ in such specimens, as every one knows who is familiar with such examinations. Even in positive cases we usually find but a few bacteria. Tissue preparations are also unsatisfactory at times and frequently in undoubted cases of infection bacteria can not be demonstrated in the sections. This is partly due to the fact that it is so difficult to get the sections thin enough for accurate bacterial study, and partly due to the early destruction of the bacteria by the phagocytes. We use in preference the toluidin blue stain, which is not difficult and at times gives good results. The various steps of this method are as follows:

Dissolve 1 per cent. of toluidin in 1 or 2 per cent. carbolic water.

Stain from fifteen to thirty minutes.

Decolorize in 95 per cent. alcohol, to which, if the color is given off slowly, add a few drops of glacial acetic acid.

If the acid is added it is again washed with 95 per cent. alcohol.

Clear rapidly in carbol xylol.

Immerse for a few seconds in oil of origanum.

Mount.

The proper degree of decolorization is reached when the sections show only a faint trace of the original blue color—in other words, show only a sharply defined stain of the nuclei, basophilic granules, and bacteria. If counter-staining is desired, the sections, after staining in toluidin blue, are immersed in water and then in a 0.5 per cent. solution of aqueous yellow eosin, where they are allowed to remain 10 minutes or longer. They are then transferred to 95 per cent. alcohol, where the dehydration and decolorization take place at the same time. They are then cleared and mounted. By this modification the fibrous tissues are stained pink.

Unna's method may also be used by simply substituting Unna's alkalin methyl blue for the toluidin blue. The other steps in the staining are the same.

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# PHYSICAL ECONOMICS.*

**[Comprising a mathematical formula for the normal earning ability of the body by which, with the requisite data a person may be either rated, or his economic value may be ascertained, and thereby damages to his body from injury or disease, with an indemnity to be allowed therefor, may be determined in a manner equitable to all concerned.]**

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An oculist, when called on to ascertain damages to the eyes from an injury, frequently meets with other disabilities of the body which occurred at the same time. If he works in connection with other physicians and surgeons who are to determine damages to other parts of the body, it is highly important that there should be standard methods of procedure which can be applied to every system and organ of the body so that each may understand the other and work together to obtain results on a scientific basis. The object of this paper is to promulgate methods by which this may be accomplished in a manner equitable to all concerned.

The problem is a mixed one, inasmuch as we must have a method for ascertaining the economic value of a person both before and after he has been damaged from injury or disease. All recognize the importance of scientific methods for solving this problem, but no one has had the temerity to attempt to overcome the difficulties surrounding it. It occurred to me, however, while I was disabled from an injury, received in 1903, that if, when the eyes were damaged, the remaining earning ability could be determined by a mathematical formula, based on the principles employed in the natural sciences in measuring any power, as had been done by

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Magnus[1] of Germany, the principle might be utilized for the whole body. I, therefore, spent many of the long weary hours of my disability in thinking how this could be accomplished. After I had adapted the principle to the whole body, it seemed so simple that I wondered if some one had not solved the problem in a similar way. On making inquiries in connection with the reprints of my papers among many persons I have failed to find any one who had solved the problem in this manner.

Professor Seaver, formerly director of the gymnasium of Yale University, replied:

> I wish to thank you for a reprint on "Physical Economics" . . . which strikes me as a very valuable contribution on a subject to which I have given considerable thought without being able to arrive at definite conclusions, and so I have never published anything. You have hit on a practical method of rating a man's physical utility so far as the physical side of him is concerned, as mental rating is given by intellectual tests, so that we may have a fairly accurate mathematical statement of his probable worth to society.

Professor Bowditch, of the Harvard Medical School, with several others, referred me to "Vital Statistics: a Memorial Volume of Selections from the Reports and Writings of William Farr, M.D., D.C.L., C.B., F.R.S., edited by Noel A. Humphreys." Dr. Farr spent his life in the Registrar-General's office of England, where by his writings on vital statistics and allied subjects he rendered one of the greatest services to his country that ever fell to the lot of man, and which made him an authority on these subjects throughout the whole civilized world.

In this work, under the head of "Cost and the Present and Future Economic Value of Man," we find: "The characteristics of life property in wages and in income from professions, commerce, trades and manufactures is that it is inherent in man and is the value of his services—of the direct product of his skill and industry. In slaves it is vendible and transferable; in freemen it is inalienable; but is not the less on that account property which in the early states of society is assessed and taxed in the form of personal services. It is combined with stock in all production; and the proportion of the elements varies in every kind of product. The labor of the parents and the expenses of attendance, nurture, clothing, lodging, education, apprenticeship, practice, are investments of capital, at risk extending over many years; and the return appears in the form of the wages, salaries or income, of the survivors, commencing at various ages, 12, 15, 21, 24, 30, 33, 36, 39, and ages still greater; for the incomes in the higher professions increases probably up to the age of 50 or 55. The outgo increases from infancy up to a certain age; the earnings then commence, and ere long equal the outgo; they are subsequently in excess throughout manhood, and at advanced age decrease, until they are extinguished amidst the feebleness and infirmities of old age. The present value of the person's probable future earnings, minus the necessary outgo in realizing these earnings, is the present value of that person's services. Like capital invested in the soil, in the vintage, or in a commercial adventure, the capital invested in the life of man returns, in happy natures, profit of a hundredfold; in other cases fifty, twenty, tenfold; in others it is barely returned; in some it is entirely lost, either by death, sickness, vice, idleness, or misfortune."

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[1] "Visual Economics," by Dr. H. Magnus of Breslau, Germany, translated with additions by Dr. H. V. Würdemann, Milwaukee, Wis.

On the "Economic Effect of Death by Different Diseases," he says: "Life has a pecuniary value. In its production and education a certain amount of capital is sunk for a longer or shorter time, and that capital, with its interest, as a general rule, reappears in wages of the laborer, the pay of the officer, and the income of the professional man. At first it is all expenditure, and a certain necessary expenditure goes on to the end to keep life in being even when its economic results are negative.

"The value of any class of lives is determined by valuing first at birth, or at any age, the cost of future maintenance, and then the value of the future earnings. Thus proceeding. I found the value of a Norfolk agricultural laborer to be £246 at the age of 25; the child is by this method worth only £5 at birth, £56 at the age of 5; £117 at the age of 10; the youth £192 at the age of 15; the young man £234 at the age of 20; the man £246 at the age of 25, and £241 at the age of 30, when the value goes on declining to £138 at the age of 55, and only £1 at the age of 70; the cost of maintenance afterward exceeding the earnings, the value becomes negative; at 80 the value of the cost of maintenance exceeds the value of the earnings by £41. These values may be compared with the former cost of slaves in Rome, in the United States, and in the West Indies.

"The amount of capital sunk in the education of professional men is not only greater, but it is probably at greater risk, and it has to remain longer under investment before it is returned. The maximum value of such a man is attained later in life, probably 40; and in the highest orders of the church, law, and politics, where experience and great weight of character are requisite, the life still increases in value at higher ages."

This method employed by Dr. Farr, and other high authorities, for ascertaining the present value of a person, at any age, must be accepted as the correct one for determining the economic value of a human being. It necessarily involves a knowledge of the bodily functions, for on the physical condition of a person depends his prospective earning ability; therefore, an examination of the body must be made to decide whether it is in a condition to meet the expectations of a working life at that age. If the examination revealed conditions which are known to lessen the expectation of life, then this fact must be taken into consideration in the calculation and materially modifies the results.

The present value of the net yearly earnings of a person for a prospective working life is the sum of these net earnings when discounted at the rate of interest, used in the computation, compounded for each of the series of years before they will be realized. This makes the interest account of very great economic importance in the problem, because the present value of any sum, due any number of years hence, depends on the rate of interest per annum and the number of years before it becomes due. The present value is very much less when a high rate of interest is used than when a low rate of interest is used in the computation, for it is the reverse of a sum to be realized at compound interest in the future.

In the computation carried out in the work of Magnus already referred to, the gross earnings are taken and multiplied by the years of the prospective working life as a base on which to determine the damages. It is manifestly wrong to take the gross earnings of a person for a base on which to determine damages to his body, for if a man was totally disabled he should, according to this method, receive an indemnity equal to his gross earnings. We must keep constantly in view that the solution of this problem is based entirely on the present economic value of a person, and that this economic value must be determined from his age and his net annual earning ability for a prospective working life at a rate of interest to be realized on a long time, as we have shown by a quotation from the writings of Dr. Farr, whose authority is recognized throughout the civilized world. There might be fixed a value for a person whose earnings only equalled or were less than his expenses in realizing those earnings, but it would have to be estimated on a philanthropic and not on an economic basis.

The method employed by Dr. Farr for determining the present value of a person from the net yearly income of his normal earning ability has much in common with the principle employed in life insurance, and, therefore, is just as accurate and reliable in its results, especially when obtained with the same care as to all the details. The economic value of a person at the time of the accident is the base on which to compute his economic loss. After we have ascertained his remaining earning ability in the form of a fraction of the normal, the economic loss may be obtained in dollars and cents.

For the purpose of determining the remaining earning ability of a person damaged from injury or disease, we need a mathematical formula for the normal earning ability of the body.

In the analysis of a person to determine the elements which are indispensable for his normal earning ability and which may be used as factors to express them in a mathematical formula, we find that the functions of the body in a fairly normal condition are of first importance. This constitutes the functional ability of the person and the factor of first importance in the formula.

A person would be of very little use, economically, in the world without having had that training of the mind and body which would fit him to follow some occupation successfully. This constitutes the technical ability of a person and the second factor in the formula. With the functional and technical ability of the first order, there is another element of a person of considerable importance, namely, his ability to secure and perform the duties of an occupation successfully. It makes no difference whether his services are rendered direct to the general public or through some employer; his success depends on his ability to obtain work and to serve those who employ him. This constitutes the competing ability of a person and the last factor in the formula. Therefore, the three elements of a person which are absolutely indispensable to his normal earning ability are, first, the functional ability; second, the technical ability, and, third, the competing ability. This analysis of a person includes everything needed in the performance of the duties of any occupation. It may, therefore, be considered complete, and, moreover, it is in accordance with the principles employed in the analysis of any physical force by which its efficiency is determined. The acceptance of this analysis of a person is of prime importance to an understanding of the mathematical formula for the normal earning ability of the body, because its object is to determine the essential elements which may be used as factors in the formula.

In a similar way that much-used substance called electricity has been analyzed; the unit of the electromotive force being designated as a volt, which is a current of one ampere, with a resistance of one ohm. The amount of electricity is obtained by multiplying these three elements together, producing a composite quantity called watts, 746 of which make a horse-power. By using the first letter of each word this process is represented in the formula $W = V\ A\ O$. When, however, electricity is obtained by this standard of resistance, its efficiency is determined by multiplying volts by amperes, and the formula thus simplified is $W = V\ A$.

In a similar manner if we use the first letter of the prominent word in the analysis of a person, $F =$ the functional; $T =$ the technical; $C =$ the competing, and $E =$ the earning ability of a person; hence $E = F\ T\ C$, the mathematical formula for the normal earning ability of the body.

These three factors are not of equal value, although the efficiency of each is interdependent on the other, F being first in importance; T second in importance; whereas C is least important, because it depends on the other two and the conditions of the labor market. The competing ability is composed of the same elements as F and is modified to a similar but less extent when F is impaired. It is also modified by T and the way employers and the public consider the person, especially when he has been damaged by injury or disease. Therefore, to meet all these conditions, C must be placed under a radical in the formula, the index of which may be designated by an X to indicate that it is to be determined in each instance, and the formula thus modified is $E = F\ T \sqrt[x]{C}$.

To amplify the formula,[2] F must be resolved into its component parts by selecting and grouping into the form of units such systems and organs as are so interdependent that each is needed to insure the functions of the other in its particular unit, and these systems and organs taken together form a unit that is absolutely indispensable to the functions of the body. These units are to be regarded as factors of F, which when multiplied together, and by the other two factors of the formula, produce the composite quantity E. As much as possible, systems and organs have been selected and grouped together as units in accordance with their development and associated functions, it being found necessary to have four such units for the whole body, which when designated by the first four letters of the alphabet are as follows:

| | | | |
|---|---|---|---|
| a = | **Osseous, articular, and muscular systems, consisting of** | **e, the bones,**<br>**f, the joints,**<br>**g, the muscles.** | |
| b = | **Circulatory and respiratory systems, consisting of** | **h, the heart.**<br>**i, the vessels,**<br>**j, the lungs and their accessory organs.** | |
| c = | **Digestive and genito-urinary systems, consisting of** | **k, the alimentary canal,**<br>**l, its accessory organs,**<br>**m, the kidneys with the genital organs.** | |
| d = | **Cerebro-spinal systems, nerves and ganglia, consiting of** | **n. the brain, its membranes, and its nerves,**<br>**o, the spinal cord, its membranes, its anterior motor, and its posterior sensory nerves,**<br>**p, nerves and organs of special sense.** | **the sympathetic nerves and ganglia.** |

Each of these units fulfills the requirements of our definition: it is composed of systems and organs so interdependent that each is needed to insure the functions of the other, and these taken together form a unit that is absolutely indispensable to the functions of the body. This being true, the value of the function of each unit may be obtained by a formula similar to that employed in determining the value of any physical force. In amplifying F, by resolving it into its component parts, as factors, a, b, c, d, each of these was resolved into its component parts, as factors, and $a = e\ f\ g$; $b = h\ i\ j$; $c = k\ l\ m$; and $d = n\ o\ p$.

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[2] The remainder of this discussion of the formula is from my article in the second and enlarged edition of the Encyclopedia Americana.

In any computation, if one of the factors becomes O, the product is O. In diseases of the bones, like osteomalacia, producing an inability to support the body, e would become O, then $a = O$; in inflammation of the joints, like chronic articular rheumatism, causing a large number of stiff joints, f would become O, and $a = O$; in diseases and injuries producing paralysis of the muscles, g would become O, then $a = O$, and finally, in diseases and injuries by which a large portion of the extremities were lost, a certainty would become O, and if $a = O$ then $F = O$. In serious valvular and organic diseases of the heart, or vessels, h or i would become O, then $b = O$; in serious diseases of the lungs and their accessory organs, j would become O, then $b = O$, and if $b = O$, then $F = O$. If the various serious diseases of the alimentary canal, its accessory organs, the kidneys with the genital organs, each of k, l, m, might become O, then $c = O$, and $F = O$; and in the various serious diseases of the brain, spinal cord, and organs of special sense, each of n, o, p, might become O, then $d = O$, and $F = O$, and finally, if $F = O$, then $E = O$. Therefore, the parts of each unit, as factors, bear the same relation to the unit, as the units, as factors, do to the whole body. Each part, as factor, is indispensable to the other, and each unit as factor is indispensable to the body. The units are always to be regarded as factors of F, and multiplied together and by the other two factors of the formula, if we are to conceive of the earning ability of the body as a whole which can be given a mathematical expression. Our formula represents, mathematically, the complete earning ability of the body in a healthy normal person, which is a composite quantity, resulting from the multiplication of factors; the same as was done in obtaining the efficiency of electricity.

As has already been shown, when F is resolved into its component parts, as factors, it is represented by $(a\ b\ c\ d)$ and $\sqrt[x]{C}$, becomes $\sqrt[x]{(a\ b\ c\ d)}$, because C is composed of the same elements as F; hence the complete formula for the normal earning ability is $E =$

$(a\ b\ c\ d)\ T\sqrt[x]{(a\ b\ c\ d)}$. Now in this formula the units, or factors, are not of equal value, and, hence, when damage to them has been ascertained by scientific standards of measurement they may be placed in the formula under a radical, the index of which will depend on how much less it is desired the damaged units shall affect the formula than that given to them by scientific standards of measurement. The unit, d, representing the cerebrospinal systems, nerves, and ganglia, would under almost all circumstances be placed in the formula at its full value, as determined by scientific standards of measurement, as any damage to it produces in the person thus affected proportional disability for all gainful occupations.

To ascertain the remaining value of a unit in a given case of damage, it must be compared with some scientific standard of measurement, and the remaining value given in the form of a fraction of the whole unit. This method, which permits of the mathematical determination of each unit of the bodily function, as a fraction of the normal unit must be considered complete, as it is in accordance with the principles laid down by the natural sciences in measuring the power of any physical force, one of which, that of electricity, has been given.

"The four units of F, or their remaining value, after being damaged, must always be regarded as factors and multiplied. Their product is a composite quantity—the earning ability of the body. They must never be regarded as quantities to be added, for wrong practical deductions would be obtained, as the following will clearly show:

In the formula, $E = (a\ b\ c\ d)\ T\sqrt[x]{(a\ b\ c\ d)}$, let us suppose that from an injury a person was rendered blind and deaf, and that, therefore, the unit, d, becomes O. It is self-evident that a person in this condition would have no earning ability, and yet, if we add the remaining units, a, b, and c, which might be normal, we would obtain only three-fourths of the earning ability of the body, which results in a *reductio ad absurdum*. With a, b, c, d, of our formula regarded as factors, to be multiplied, however, when d, or any other factor, becomes O, the product is O, also, and no absurdity results, because in any computation, if one of the factors is O, the product will always be O. If a person has no technical ability, T would be O, and, therefore, E = O. This would be true in actual practice. Finally, if we decide that a person has no competing ability x = O, and E = O, and this would be true in the labor markets, notwithstanding the bodily functions might be normal and the technical ability might be of the highest order, yet if the person's services were not needed and he could not dispose of them at any price, his earning ability would be O. Therefore, in our mathematical formula for the normal earning ability of the body, if any one of the units as factors becomes O, then E = O, and no absurdity results. We have, at some length, dwelt on F, of our formula, because it is the most important factor in it. We now pass on to T, the next in importance.

The technical ability of a person is usually gained during adolescence, and is generally attained by the time the growth of the body is completed. The formula may be used as a guide during the years of growth and development and serve to rate the youth, taking into consideration the condition of the functional ability on which the mental and technical ability so much depend, but which has been heretofore practically ignored. As important as T is to the normal earning ability, and in rating a person, when that person's vocation becomes fixed, T may be considered as equal to one in estimating damages. The technical ability is not injured, but limited only in proportion to the damages to F, impairment of which will include these damages; therefore, T may be omitted, and the formula thus modified for determining damages to the earning ability of the body is

$E = (a\ b\ c\ d) \sqrt[x]{(a\ b\ c\ d)}$.

We now come to C, the third and last factor of our formula. The ability to compete is a condition which is affected by a variety of circumstances; first, by the person's functional ability; second, by his technical ability; and, third, by the way employers consider these conditions, together with the supply and demand for labor. Therefore, when a person becomes disabled, the damage to his body acts immediately in two ways: first, by its direct impairment of the functional ability, according to the nature and extent of the damage by reason of which he will not be able to perform so much, and perhaps not so good work, as he did before; and, second, by the way employers consider these conditions. The damage to the body might be of such a nature as to effect the appearance of the person without interfering materially with his earning ability; such as in the unit a, loss of the auricles, or nose; in the unit d, a large scar of the cornea, or an injury to a blind eye causing it to become crossed. Disfigurements like these, although not interfering with a person's ability to work as well as he did before the damage was done, would seriously interfere with his chances to obtain employment, and should, therefore, be considered a serious obstacle to his competing ability. In case of damages, a person has a right to secure compensation, not only for the loss to his functional ability but also to his appearance, when it seriously interferes with his ability to obtain employment in the grade of work and command the wages to which he is entitled. The part of his ability to compete not represented in the person himself, but in the way employers consider the damages we render in the number selected for the index of the radical of the competing ability. In general, if a person has no competing ability we would select 0; if it is seriously affected we would select 2 or 3; if only moderately affected 5 or 7; and if but slightly affected 10, for the index of the radical of the competing ability. By leaving this to the physicians who have ascertained the damages to F, and who are the most competent to judge what it shall be, disabilities of the body, and an indemnity to be allowed therefor, may be determined in a manner equitable to all concerned.

The higher mathematics involved in the extraction of the roots of the radicals are avoided by the construction of a chart by Prof. Hart of the University of Maine, by which geometric curves represent the different roots; the value of the abscissa being given at the top and bottom, and that of the ordinate on either side. By taking the remaining decimal value of the unit of the body, as abscissa, and tracing the line to the geometric curve representing the root sought, and from this point following the ordinate to its end on either side, the value of the root will be found. Inserting this value in the formula. the process of finding the remaining earning ability and thereby the damages to the body is one of simple computation, involving no more mathematics than an example in interest or partial payments.

Although it is true that scientific standards of measurement of all the parts of the units of the body have not been determined and agreed on, nevertheless it is a self-evident fact that anything that is used must have a value placed upon it, and when this value has been measured, tested, compared, and estimated in a scientific manner, in a large number of normal healthy persons, and an average value ascertained, this average value becomes a scientific standard of measurement for that particular part of the unit of the body. It is in this way that all the scientific standards of measurement, now employed, have been determined and agreed on, and it is in this way that all the remaining ones must be established. Until this work is consummated we shall have to employ such standards as have been agreed on, and by the same methods by which these have been obtained determine values for all the remaining systems and organs of the units of the body which will eventually be accepted as scientific standards of measurement.

In ascertaining damages to the body, a physician must first determine what the impairment of the function of the unit is, and then, by comparing this with the case record and the scientific standard of measurement for it, give the remaining value in the form of a fraction of the whole unit in the formula. The principles and process then are the same as those employed in determining the efficiency of any physical force. It will be seen that it is the damaged functions that the physician first seeks, and not necessarily the pathology of the damaged unit. To illustrate this, a physician might in examining the eyes find the sight seriously impaired, the fields markedly contracted, and the muscular movements badly deranged. He could determine the exact functional disability of each of these units of the eyes by the scientific standards of measurement for them, and give the remaining value of each unit in the form of a fraction for the Magnus formula, and thereby ascertain the remaining earning ability of the eyes without knowing the pathology of the disabilities. The exact nature of the disabilities could not be determined without instituting an examination which would reveal their pathology, and therefore the physician could not state whether the disabilities were temporary or permanent without such an examination. The pathology of a disability is necessary only to determine its character, whether transitory or permanent, serious or not, as the case may be, and should not be made the basis to determine the remaining earning ability of the body. The earning ability is a composite quantity made up of the physiologic functions of the systems and organs of the units of the body, each of which is interdependent on the other in making man the most wonderful product of nature.

In youth and the beginning of manhood, we can only rate a person according to his functional and his technical ability, but when that person has a fixed occupation we can, thereby, determine, by our formula, his earning ability and his economic power in the world as accurately as we can that of any physical force. We can determine his mental ability only so far as it is manifested in his vocation and the importance placed on it as evidenced in the remuneration he receives for it. We can not figure on possible prospects of advancement, nor change of occupation. We can only figure on the actual conditions of life as they exist, and when accidents occur, causing damage, on the supposition that these conditions would continue for a length of time thereafter according to the basis on which the American experience table of mortality has been constructed and on which has been established life insurance—the first business of the world.

The value of the functions of the body cannot be determined, for health, like character, is priceless. Even the possession of health much below any economic value is priceless, and is clung to under all conditions of privation and suffering. This does not affect the purpose of our formula, which represents mathematically the normal earning ability of the body. This has solely to do with the individual's ability to perform certain services and to receive a specific compensation therefor for the remainder of a prospective working life. No life insurance company would consider a risk on a man's life for an amount his business or wealth did not warrant. A man who has no income whatever and could offer no collateral would be refused a loan of money from any person, or bank, and he could not obtain money except by reasons which are foreign to the rules of business. A person with good habits and a steady occupation with a specified income would be able to hire money on that alone, in proportion to his income, other things being equal. The time is coming when the earning ability of man will be rated and will be just as valuable in the labor market as in the rating of his financial ability to-day in the business marts of the world.

We will now proceed to illustrate the use of the formula in the case of a young man whose eyes were severely damaged and the right hand badly burned by a current of electricity sufficient to kill two men instantly.

W. O'B., aged 20, mill employé, June 22, 1900, while standing on an iron platform and handling a portable electric light, received a current of electricity sufficient to throw him down instantly. Two of his fellow-workmen who saw him fall quickly went to his aid and, in attempting to pull him away from the platform and the wire of the lamp, which was burning his hand, both were killed instantly. The electric current was shut off as soon as possible and Mr. O'B. was extricated from his perilous position. Dr. G. F. Webber of Fairfield, Maine, was called to attend him and stated that the flexor tendons of the thumb and forefinger were burned off and the flesh of the other fingers was burned severely. The hair and scalp to the size of a silver dollar were burned off where the back of the head rested on the iron platform. He was unconscious for seven or eight hours after the accident.

There was evidence that the wires, of the electric light company, outside the mill became crossed in the mill yard, the primary wire carrying a current of 2,200 volts.

When the wound healed the thumb became adherent to the forefinger so he was unable to grasp anything between the forefinger and the thumb. His sight was seriously affected, and he came under the care of Dr. J. F. Hill of Waterville, Maine. He also consulted Hon. Charles F. Johnson of Waterville to ascertain how he might recover damages for his injuries.

On Sept. 13, 1901, I made an examination of Mr. O'B. with the following results: Vision right eye 0.1, no improvement with lenses. Vision left eye 0.4, no improvement with lenses. Corneal astigmatism right eye, 1 D. at 90°; left eye, 0.8 D. at 90°; abduction, 4°; adduction, 14°; esophoria, 5½°; sursumduction right eye, 3°; left eye, 3°. Deciphers type No. 10 (3½ mm. in height). The right field of vision was contracted 30° on the temporal side and 20° above, below and on the nasal side. The left field of vision was contracted about 10° in all directions. No limitations of the muscular movements were recorded.

Examination of the interior of the eyes showed the media fairly clear, so that the retina and optic nerve of each eye could be seen readily. It was evident from the ophthalmoscopic appearance that both the nerve and retina of each eye, especially of the right eye, had suffered from inflammation, but, of course, there was nothing in the slight changes to indicate the cause of it or when it may have occurred.

He was examined again on Dec. 27, 1901, and his condition was found to be about the same as here recorded.

The suit was brought for $5,000, and the trial took place at

Skowhegan, Maine, in December, 1901, Hon. A. S. Littlefield of Rockland being the attorney for the pulp mill company. Mr. Littlefield consulted me about testifying for the defense. After I stated to him I was engaged, and the substance of my testimony, he did not engage any one to testify as to the condition of the eyes, but engaged Dr. W. P. Giddings of Gardiner, Maine, to testify as to the physical condition of Mr. O'B. After a trial of several days the jury rendered a verdict for Mr. O'B. of $3,271. This verdict was set aside afterward, because of the erroneous ruling of the judge who held the pulp mill company liable for negligence of the electric light company which supplied the electricity.

As to the verdict and a new trial Mr. Johnson writes me: "I am, of course, very much disappointed that the verdict should be lost on what really had nothing to do with the decision of the case, for if the jury had been correctly instructed by the court, I feel very certain that the result would not have been changed, but as attorneys, we have to learn to take the bitter with the sweet. I intended to try the case the second time, but the young man's brother-in-law, who was able to furnish him some financial assistance, died, and in the meantime the young man's hand was operated on in the hospital at Augusta, where I got him a free bed. After the operation he was able to use it more than before and found employment in the woolen mills at Fairfield at the same price per day which he had received in the pulp mill. He never will, however, have a good hand, and the work about which he is employed in the woolen mill does not call for very much use of his hand. Certainly through the remainder of his life he will not have more than one-half the use of that hand. The last time I saw him in 1905 his eyesight was no better. When he undertook to read or look at an object steadily, or for any length of time, his eyes manifested very marked signs of weakness. For the work about which he is now employed it is not necessary that he use his eyes very much. I think otherwise he has been in good health and has continued to work in the woolen mill.

"The insurance company[3] made an offer of $1,000, which could not be considered in any light adequate compensation for his injuries. However, he had no money to continue litigation, and he was able to work some, and there were troublesome questions of law about the liability of the defendant company, as well as the question about collecting an execution from the pulp mill, I thought it best to accept the offer.

"Since I heard your lecture on physical economics at Waterville I have been very much interested in the subject. The

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[3] The insurance company was one that insured the pulp mill company against liabilities for injuries to its employés and against the cost of defending suits to the amount of $5.000 in any individual case.

**question of what are adequate damages for personal injuries is always a very troublesome one for the courts, and the juries have no certain guide to go by. It seems to me that you have developed a practical method for rating a person and for determining damages to the body from injuries or disease, and I shall hope to see it in daily use in the near future."**

The position I took at the trial was that, inasmuch as Mr. O'B's eyes had never been examined and there was no record of the condition of the eyes before the accident, I could only state the condition I found them in, and the probable effect this would have on his future earning ability. In answer to a question as to the probable effect of a current of electricity of high voltage on the brain and organs of special sense, I replied that it could not be definitely determined without a carefully made record of the condition of a person before it passed through these organs, but in this case, inasmuch as two of Mr. O'B's comrades were killed, instantly, by the current which must have passed through his body to them, and there was no history of weak eyes to offset the claim that his eyes were good and strong before the accident, it was fair and equitable in my opinion, to assume that they were good before the accident. This testimony was acceptable to both parties to the suit.

In determining the damages to Mr. O'B. in consequence of the partial loss of the functions of the eyes, it was necessary to consider the loss of central and peripheral vision. Central vision was reduced to 0.1 normal in the right eye, and 0.4 normal in the left eye. As normal vision according to the standard of measurement is not essential to mill employés, that is, a large number of them earn and receive full wages when vision is very much below this scientific standard of measurement for normal vision, it could be assumed that the fractional part of the loss of vision lessens the earning ability of the eyes to that same amount. At the time of the accident the American edition of Magnus' work had not appeared. I find, however, that my estimation of the effects of the loss of vision on the earning ability of Mr. O'B. at that time, correspond very nearly to the results obtained by the standard adopted by Magnus, as I assumed then from an examination of a large number of laborers of different vocations that one-half of the scientific standard of measurement for normal vision was sufficient for full earning ability, provided the fields of vision of each eye were nearly normal.

The loss in the field of vision in this case, especially of the right eye of 30 degrees on the temporal side, I regarded seriously as it is the same in amount as when one eye is entirely lost, and no matter in what direction Mr. O'B. looked there would be just so much narrowing of the field of vision, and a corresponding detriment in his ability to work in any vocation and protect himself from dangers without that are constantly menacing persons with such a disability. Considering the damages on this basis, I determined the economic loss to Mr. O'B's eyes 3/8 of the whole, and, therefore, the remaining earning ability 5/8. This corresponds closely to the results obtained by Mangus' method by which I figured it after the American edition of that work appeared.

As much as we all admire the work of Mangus, and the additions made to it by the translator and editor of the American edition, Dr. Würdemann, it is not satisfactory to determine damages to the eyes by one method, and damages to another part of the body, which were caused by the same injury, by an entirely different method, therefore I saw the necessity of adapting the principle employed by Magnus in his formula for the normal earning ability of the eyes to the whole body, and developed the mathematical formula for the normal earning ability of the body, the application of which to solving problems in cases of damages to the body from injury, or disease, with an indemnity to be allowed therefor, is the object for which this paper has been prepared.

In determining the remaining earning ability of Mr. O'B. by the mathematical formula for the normal earning ability of the body, we will ascertain the remaining earning ability of the eyes, first, which are a part of one of the factors in unit *d*.

The eyes, as Magnus has clearly demonstrated, have three factors which are absolutely indispensible to their normal earning ability, namely the central acuity of vision, the field of vision, and the muscular movements. Although these factors are not of equal value, and for that reason are placed under a radical in the Magnus formula, nevertheless if either one of the two lesser ones in value be totally destroyed the earning ability of the eyes likewise will be destroyed.

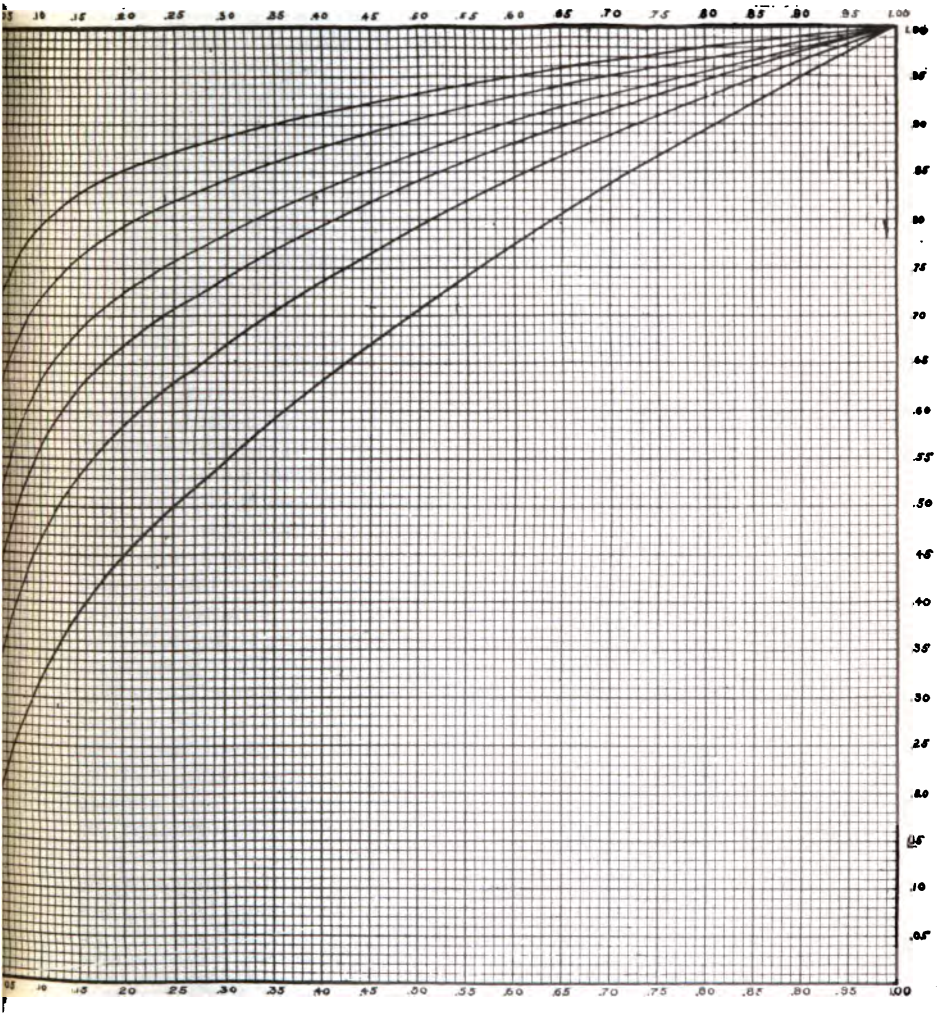
Mr. O'B's best eye, the left, which determines his central acuity of vision, was 0.4 normal scientific standard of measurement. Assuming that 0.5 normal scientific standard of measurement is sufficient for full earning ability, which is the standard adopted by Magnus for mill employés, he had lost 1/5 of the sight actually needed in this vocation, and therefore had 4/5 left, which is one of the factors of the coefficient of the unit *d*. The vision of the right eye was 0.1 of the normal scientific standard of measurement, and the loss in the field of vision on the temporal side was 30° of the normal scientific standard of measurement. If the binocular field is divided into three zones, as suggested by Schroeter, and practiced by Magnus, there will be six zones of 30° each, and as the outer zone of 30° was gone, there was 5/6 left, which in consideration of the serious loss of vision of this eye, should be placed in the formula at its full value as the other factor of the coefficient of the unit *d*.

The defect in the muscular balance of the eyes (esophoria) and the weakened accommodation were not thought sufficient to be taken into account in the calculation.

The objective damages to the body are included in the unit *a*. The damage to the scalp could be concealed by the hair and the real damage from this particular part was to unit *d*, which has already been determined.

The damage to the right hand was severe. In looking for a standard of measurement by which the loss of the function of the hand could be compared and its remaining economic value be determined, I feel sure that all who saw the case would agree that the disability was equal to, or greater, than anchylosis of the wrist, and his competing ability would be less than a person suffering from anchylosis of the wrist, because in anchylosis of the wrist, there would be no scar, or deformity, only the loss of motion, whereas Mr. O'B. had loss of motion and a bad looking scar of the hand. If this disability of the hand is considered equal to that of anchylosis of the wrist, for which the standard of the Bureau of Pensions of the United States is one-ninth of total disability and which I have shown in a paper read before the National Association of United States Pension Examining Surgeons, at Atlantic City, published in their transactions for 1904, is equivalent to 10 per cent. of total disability when placed in the mathematical formula for the normal earning ability of the body and the competing ability considered, we have 9/10 of the unit *a* left, which is its coefficient. Discarding all undamaged units of the formula, we have as an expression of the remaining earning ability of the body of Mr. O'B. when placed in the formula the following:

$$E = 9/10a\ (4/5 \times 5/6)d\ \sqrt[x]{9/10a\ (4/5 \times 5/6d} = 0.60\ \sqrt[x]{0.60.}$$



It is necessary now to ascertain Mr. O'B's competing ability. His right hand was a bad looking one, and moreover its functions were not one-half what a normal hand should be, which would prevent him from obtaining employment in many occupations. Taking the objective disability of the right hand, and the subjective disability of his eyes, we choose 5, as fair and equitable for the index of the radical of his competing ability on a scale of 2 being used when the competing ability is the most seriously affected, and 10 when it is but slightly affected. We then have $E = 0.60 \sqrt[5]{0.60} = 0.60 \times 0.905 = 0.543$: $E = 54.3$ per cent. Therefore, Mr. O'B.'s remaining earning ability is 54.3 per cent. of his normal earning ability, and, hence, his economic loss is 45.7 per cent. The loss in wages and other necessary expenses connected with the injury are as follows:

| | |
|---|---|
| Two and one-fourth years' wages at $375...... | $843.75 |
| Less $80 earned canvassing during this time.... | 80.00 |
| | $763.75 |
| Physician's bill for services ................ | 208.00 |
| Druggist's bill for medicine.................. | 30.00 |
| Care and nursing, estimated.................. | 42.00 |
| Cost of treatment at hospital estimated........ | 58.00 |
| Making a total of.................... | $1,101.75 |

This should be added to the loss of the earning ability.

We will now proceed to determine the present value of Mr. O'B. at the time of the accident from his age and the wages he was earning. He was 20 years old and was earning $1.25 per day. Assuming he would work, on an average of 300 days in the year, his income would be $375. This would allow thirteen days each common and fourteen days on leap year for sickness or vacation. It is a close approximation to what ought to be actually realized. The cost of maintenance, as Dr. Farr says, is an estimate, but it must be remembered that any transaction of man must have a value placed on it and when this value has been measured, tested, compared and estimated in a scientific manner, in a large number of instances and an average value ascertained, this average value becomes a scientific standard of measurement for the value of that particular transaction.

We need a standard of measurement for the economic value of man[4] in two vocations, the average laborer, and the average professional man. The first should be obtained from the wages of a laborer of average minimum capacity, based on his age, his physical condition and his income. The present value of the net income must be computed at a rate of interest that has been accepted as a standard for such computations, which we have assumed to be 3.5 per cent., as nearly all insurance values are figured at this rate.

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[4] The Bureau of Pensions of the United States has established $864 for total disability, for a soldier or sailor. As total disability requires the regular aid and attendance of another person it may be inferred that this amount represents the gross earnings of two persons, and, therefore, the earnings of one would be one-half of it or $432 a year, $36 a month, and $1.44 a day.

As this has not been done in this country on an economic basis, we will accept Dr. Farr's standard for a Norfolk agricultural laborer, who at the age of 20, earned £23 a year, at the age of 25, £29 a year, and at the age of 30, £31 a year, and thereafter until the age of 60, £31 a year. Taking an average of £29 a year and reducing it to dollars and cents, we have $140.94. Dividing $375 by $140.94 and we obtain 2.66 as the ratio between a Norfolk agricultural laborer and the wages Mr. O'B. was earning. Multiplying the standard for the present economic value of a Norfolk agricultural laborer as determined by Dr. Farr on a basis of 5 per cent. per annum by 2.66, and we have a standard for an American laborer, on the same basis.

In another table Dr. Farr determines the present economic value of a Norfolk agricultural laborer on a basis of 3 per cent. With this and the 5 per cent. table, we obtain one on a 4 per cent. basis and with the 4 per cent. and 3 per cent. we obtain the present economic value on a 3.5 per cent. basis, which are as follows, from birth to 70 years of age.

| Age | Total | Died | English 5% basis | American 5% basis | 3½% basis | 3% basis |
|---|---|---|---|---|---|---|
| Birth | 513 | | $26.10 | $69.43 | $119.54 | $146.64 |
| 5 | 372 | 141 | 271.87 | 723.17 | 1,245.16 | 1,518.03 |
| 10 | 355 | 17 | 568.04 | 1,510.99 | 2,601.62 | 4.169.66 |
| 15 | 346 | 9 | 930.93 | 2,476.27 | 4,263.66 | 5,194.59 |
| 20 | 335 | 11 | 1,135.25 | 3,019.77 | 5,451.75 | 6,295.74 |
| 25 | 321 | 14 | 1,198.26 | 3,227.37 | 5,488.03 | 6.686.29 |
| 30 | 307 | 14 | 1,172.06 | 3,117.68 | 5,368.03 | 6.540.09 |
| 35 | 291 | 16 | 1,109.15 | 2,950.34 | 5,079.91 | 6,189.06 |
| 40 | 275 | 16 | 1,030.42 | 2,740.09 | 4,719.32 | 5,749.73 |
| 45 | 257 | 18 | 936.81 | 2,491.91 | 4,290.59 | 5,227.40 |
| 50 | 237 | 20 | 718.29 | 1,910.55 | 4,089.77 | 4,007.96 |
| 55 | 215 | 22 | 669.80 | 1,781.67 | 3,067.68 | 3,737.48 |
| 60 | 189 | 26 | 472.49 | 1,257.12 | 2,163.90 | 2,636.49 |
| 65 | 156 | 33 | 223.56 | 594.67 | 1,023.90 | 1,247.46 |
| 70 | 118 | 38 | 3.74 | 9.95 | 17.13 | 20.87 |
| 75 | 79 | 39 | 119.31 | 317.37 | 546.44 | 665.75 |
| 80 | 44 | 35 | 199.31 | 530.16 | 872.84 | 1,112.15 |

Multiplying the present economic value for the age of 20, as here obtained by the percentage of the remaining earning ability of Mr. O'B., and we have the amount of his remaining earning ability. Subtracting this remaining earning ability from his present economic value and we have his economic loss, then adding his loss in wages and his expenses after the injury, and we have his total economic loss as follows:

**$3,019.77 × .543 = $1,639.74; $3,019.77 — $1,639.74 = $1,380.03;**
**$1,380.3 + $1,101.75 = $2,481.78, 5 per cent. basis.**
**$5,451.75 × .543 = $2,960.30; $5.451.75 — $2,960.30 = $2,491.45;**
**$2,491.45 + $1,101.75 = $3,593.20, 3½ per cent. basis.**
**$6,295.74 × .543 = $3,418.58; $6,295.74 — $3,418.59 = $2,877.16;**
**$2,877.16 + $1,101.75 = $3,978.91, 3 per cent. basis.**

Thus we see that the total economic loss to Mr. O'B. varies according to the rate per cent. used in computing his present value at the time of the accident. To whichever amount that may be accepted as equitable, should be added such a sum for the suffering in mind and body, as may be warranted on philanthropic grounds.

When these methods are accepted as a means of adjusting damages to the body from injury or disease, it will be necessary only to determine who was responsible for the accident that caused them, then the settlement may be made in a manner equitable to all concerned.

The amount for which suit was brought, ($5,000) in view of the serious damage to Mr. O'B., was not an unreasonable sum for such damages, as shown by his economic value at the time of the accident and from his remaining earning ability, as determined by scientific and economic standards of measurement, and the mathematical formula for the normal earning ability of the body. When the present value of Mr. O'B. is determined at the rate of 5 per cent. discount, the amount that should be paid him is $789.22 less than the amount of the verdict rendered by the jury; when determined at 3.5 per cent. it is $322.20 more than that rendered by the jury; while at 3 per cent. it is $707.91 more than that rendered by the jury.

We believe that if the jury, in this case, could have had these methods, as here worked out, demonstrated to them, their duty would have been easier to perform and the results would have been more satisfactory to themselves. However, we have no criticism to make on the verdict rendered, considering the standpoint from which it was ascertained.

In determining a standard of measurement for the present value of a man in the United States, we believe that the wages earned by Mr. O'B. at the time of the accident, $1.25 per day, are an average minimum for this country and that the rate of interest of 3.5 per cent. per annum, may be accepted as a standard for the computation.

Dr. Farr determines the present value of persons in professions on moderate incomes, earning £288 a year, net, or $1,399.78, practically $1,400, net, or $4.50 per day, net, interest 3 per cent., as follows:

| | | |
|---|---|---|
| 1. | Age 25, economic value | $25,808.94 |
| 2. | Age 30, economic value | 27,702.00 |
| 3. | Age 35, economic value | 28,921.86 |
| 4. | Age 40, economic value | 29,344.68 |
| 5. | Age 45, economic value | 28,829.52 |
| 6. | Age 50, economic value | 27,138.24 |
| 7. | Age 55, economic value | 23,974.38 |
| 8. | Age 60, economic value | 19,337.94 |
| 9. | Age 65, economic value | 13.209.48 |
| 10. | Age 70, economic value | 2,988.00 |

It will be seen by reviewing the methods by which the damages to Mr. O'B. have been determined, that every step in the process has been taken with a well-defined object in view, and that it has been accomplished by the use of a mathematical formula for the normal earning ability of the body, based on the principles employed in the natural sciences in ascertaining the value of any physical power, and therefore is scientifically correct. The two values to be determined in the case were first, his remaining earning ability, in the form of a fraction of the normal earning ability, and second, his economic value at the time of the accident. We determined the first by comparing the conditions found in the eyes with such economic standards of measurement of the eyes as have been found by the examination of a large number of cases by different observers to be sufficient for a mill employé to perform the work required of him successfully, and give the remainder in the form of a fraction for each of the factors of the eyes thus involved. These remaining values of the factors of the eyes were multiplied together for the coefficient of the unit *d* to which they belong.

We obtained the remaining value of the hand by comparing the disability with the standard of measurement established by the Bureau of Pensions of the United States for all minor disabilities, namely, anchylosis of the wrist, by which millions are paid to soldiers and sailors annually. We then had the remaining value of the damaged units *a* and *d*, as their coefficients, and discarding *b* and *c* because not considered injured, and therefore equal to one each, we have the formula complete for working, except the index of the radical of the competing ability. The number for the index of the radical of the competing ability determined by a method based on principles as well defined as those employed in rating a person at school or college. With this chosen, we proceed to work the formula according to the principles upon which it is constructed, and obtained the remaining earning ability of Mr. O'B. in the form of a fraction of the normal earning ability as 54.3 per cent.

Thus every step of the process to determine the economic value of the damage to Mr. O'B. in consequence of the injury he received June 22, 1900, has been taken with a well-defined method of procedure, as that of weighing or measuring of any commodity and then multiplying the quantity by the price per unit of the standard of measurement for that commodity, in order to obtain its value. The final result then can not be questioned on the ground of the want of care in obtaining it, it can only be questioned on the ground as to whether the principles on which the methods are based are correct and give results that are right and equitable to all concerned.

On both of these points we have the highest authority, for my formula for the normal earning ability of the body is based upon the principles employed in the sciences in determining the value or efficiency of any natural power. It was employed by Magnus in his mathematical formula for the normal earning ability of the eyes. My work has been to adapt these principles to the entire body by selecting and arranging the different systems and organs according to their development and associated functions, that all the essential parts of the body may be grouped under four units, which may be used as factors of the functional ability in a practical workable formula as readily as though the principles were applied to but one organ at a time.

For the success and approval of this work, I have quoted from one of the many letters which I have received, because Dr. Seaver. as he writes, has spent a large part of his life in studying the body, to develop, measure, and utilize it to the best advantage. He has written one of the best works on anthropometry and physical examinations in the English language, and therefore his opinion is an authority on this subject.

As to the method of determining the present economic value of a person, I have quoted from the highest English authority, and therefore, of the world, because the science of vital statistics owes its existence largely to English writers, the greatest of whom was Dr. Farr.

After admitting the principles of the methods and every step of the process taken in the solution of this problem are correct, it might be argued that the final result is not equitable because Mr. O'B. has obtained work in a woolen mill for the same wages he received at the time of the accident.

This argument would be too fallacious to need refutation when the history of the case and the conditions under which Mr. O'B. now works are taken into consideration. He must at the best, always take an inferior position. The current of electricity which passed through his body was sufficient to kill two men, and the bad effects may gradually develop, thus farther disabling him. This is no small consideration in the problem, but it is not taken into account in the result obtained. We have endeavored to be conservative in every step of the process, and believe the result is obtained in a manner equitable to all concerned.

One important datum is lacking in the absence of a record of an examination of the eyes before the accident, and, therefore, we are unable to assert positively that the conditions of his eyes, as found after the accident, was due to the injury, but we are confident that the position taken is fully justified by the history of the case, and the nature of the injury.

We have gone into the details of this case at considerable length, because it illustrates how well the formula is adapted to working out the remaining earning ability of a person when one or more of the units of the body has been damaged by injury or disease, and, therefore, it is a type of all such cases.

If Mr. O'B. had had a record of an examination of his eyes showing that they were normal prior to the accident, all doubt on this point would have been removed. This again shows the necessity of every person having a case record of his physical condition, for no one knows when he may meet with an accident and need it to determine just what the amount of the damage is from a given injury. If the history and examination revealed a suspicion that a part of a disability existed prior to the accident for which damages are claimed, and this should be. by further evidence in the case, established beyond a reasonable doubt, then the fact must be taken into consideration in determining the amount of the damages due to the accident. To avoid disputes and litigations every person should have a carefully made record from repeated examinations of his body.

This would be of great value to a person, not only in case of injury, but also in the treatment of any disease.

The progress of medicine is towards preventing, rather than curing diseases, and in order to make this practice more complete, the time is coming when physicians will be largely occupied in making these examinations and case records, and thereby preventing rather than curing diseases. There is nothing of more importance to be instituted in the science and practice of medicine for its welfare and advancement than the carefully made records of the physical and laboratory examinations of every person. To make them more effective they should be instituted when the child enters school, and be repeated at stated times during the whole period of school life. This would necessitate establishing a new officer, the school physician, not an inspector of the schools, but one who would take a child, analyze him, detect all abnormalties and in conjunction with the parents and other physicians correct them during school life, and thus have the body improved with the mind, that each may help the other to the fullest development. From these records data could be obtained which, when applied to the mathematical formula for the normal earning ability of the body, and worked out according to the principles on which it is constructed, would give the rating of a child, taking into consideration his functional ability on which his technical ability so largely depends, but which has been heretofore almost entirely neglected in rating him. With this work carried out during school life, it would soon demonstrate its own importance, by making these records of the highest value in the training of the mind and the body, the advancement of the race, for the promotion of health and the prevention of disease, and in furnishing data to determine damages to the body from injury or disease by the mathematical formula for the normal earning ability of the body, in a manner equitable to all concerned.

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ONE HUNDRED AND THREE DEARBORN AVENUE.
1906.

# RELATIONS OF THE SUPERIOR AND INFERIOR RECTI MUSCLES TO CONVERGENT SQUINT.*

EDWARD JACKSON, M.D.

DENVER, COLO.

Since the last meeting of the Section on Ophthalmology of the American Medical Association I have had the opportunity of studying another case in which extended tenotomy for convergent strabismus was done five years ago. This case, which illustrates some of the points to which I wish to call attention at this time, is briefly as follows:

*Patient.*—Mrs. C., aged 51, has suffered from alternating convergent strabismus for many years, probably from childhood. She has irregular astigmia with low myopia.

R. 4/12 with —1 = —0.25 cy. ax. 90° = 4/9, mostly.
L. 4/15 with —1 = — 0.75 cy. ax. 165° = 4/9.

The squint amounts to 35 or 40 centrads, and with prisms of this strength, base out, she obtains binocular single vision. Stronger prisms give crossed diplopia.

*Operation.*—June 17, 1901, under cocain, I stretched the right internus and nasal margins of the right superior and inferior recti; then divided the insertion of the internus and the nasal half of the insertions of the superior and inferior recti, in the manner described last year.[1] A good deal of convergence remained until the inferior tendon was cut. Then the eye became quite straight. The next day all dressings were omitted. This caused some dizziness and confusion so that she "wished to keep quiet." The eye seemed quite straight. There was no deviation or recovery under cover, when looking straight ahead, but movement of the right eye toward the left was markedly limited, and diplopia appeared when the object of

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

[1] THE JOURNAL A. M. A., Aug. 19, 1905, p. 522.

**fixation was carried from the right to the left field, or brought close to the eyes. Two days after the operation there was less confusion about walking and using both eyes, and few mistakes as to the position of objects. At the end of one week: "Eyes feel more comfortable than before the operation; free from a strained feeling." There was now exophoria of 3 or 4 centrads, and inward movement of the right eye was still much impaired.**

***Result.*—Feb. 10, 1905. She has not been wearing any glasses for nine months. Vision is: R. 4/12 mostly, L. 4/12, neither improved by glasses. The muscle tests show complete orthophoria at distance with exophoria, 8 centrads, at 12 inches. She is given R. and L. + 0.75 sph., with prism 1.5 centrads, base in, for near work.**

The failures of ordinary tenotomy to cure strabismus have been sufficiently set forth and enlarged on, of late years, by a considerable number of ophthalmologists; but it may be mentioned that advancement also has its failures, which have not been so much exploited. No one speaks of advancement as a discarded operation. We do not hasten to report failures when others are putting on record only successes; but it is not a sufficient recommendation for an operation that it does not leave the patient any worse off than he was before, however much of an improvement that may be over the earlier record of tenotomy. A careful consideration of the relative shares which the primary and secondary adductors and abductors of the eye take in its lateral movements will show some of the reasons for our failures and some of the special dangers of tenotomy.

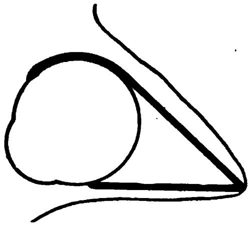

**Figure 1.**

With the eye in the primary position, contraction of the internus tends to adduct it. As this contraction increases, its influence over the position of the eye progressively diminishes. The shortening of the muscle renders its pull less powerful; the unrolling of its tendon, so that it no longer acts in a tangent to the globe, renders it less effective, and the elongation of its antagonist, bringing into play its elastic tension, and wrapping it around the globe, enables it to render more effective resistance. These conditions are represented in Figure 1, which shows the relations of the internus and externus to the globe during extreme adduction.

In like manner, the contraction of the externus tends to abduct the eyeball with a power that progressively diminishes. The shortening of the muscle diminishes its tractive power, while the lengthening of the internus brings into action its elastic contractility and progressively increases the resistance that it offers to the externus. This may be understood by glancing at Figure 2, which represents the relations of the parts during extreme abduction of the eyeball. As either the externus or the internus draws the eye away from the primary position, its relative power over the position of the eye diminishes, while that of the opposing muscle increases. These muscles tend to a stable balance, with the eye near the primary position. So far as these two muscles are concerned, the eye drawn away from the primary position tends to return to it.

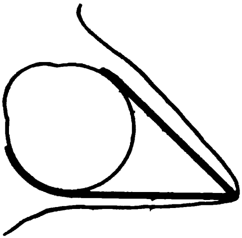

Figure 2.

The reverse of this is true with the secondary adductors and abductors of the eyeball. These adductors, the superior rectus and inferior rectus acting together, apply their force to the eyeball in front of the center of rotation. When the eye is in the primary position, their power to rotate the eyeball inward is comparatively slight. When the eye is turned out so that the direction of the action of these muscles passes through the center of rotation of the eyeball, they have no tendency to turn it inward. Or, rather, the nasal portion of the muscle, tending to turn the eye in, is balanced by the temporal part of the muscle, tending to turn it out. This will be understood by Figure 3, in which the eye is represented as looked on from above, the position of the center of rotation being shown lying under the center of the superior rectus muscle. The muscle is on a "dead center" as regards lateral rotations.

When, however, the eye is strongly converged, the influence of the superior and inferior recti in turning the eye inward is as great or greater than that of the internus. This is shown in Figure 4. in which the muscles are represented by the single heavy line. With the rotation inward the insertions of the superior and inferior recti tendons are carried inward, the muscles depart farther and farther from the line of the "dead center," and at the maximum of convergence they exert their maximum influence toward turning the eye in or holding it there.

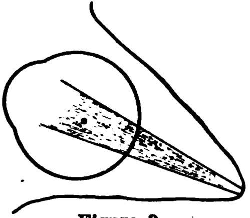

Figure 3.

The physiologic purpose of this arrangement seems to be to render the eye movements easy and steady, up to near the limits of the field of fixation. The primary adductor, the internus, initiates the convergence movement. As this goes on and becomes more difficult, however, and the internus is placed more and more at a disadvantage, the secondary adductors come to its assistance and take up the greater part of the work. The more the eye converges, the more do the secondary or accessory adductors tend to make it converge and the more is the externus placed at a disadvantage in its efforts to overcome the convergence.

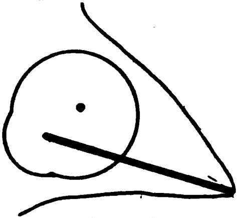

Figure 4.

It should be noted, also, that in overcoming extreme convergence the externus works alone. Of the secondary abductors, the obliques, it is true as of the secondary adductors that the more the eye is turned in the direction that they act the more power they have to pull in that direction. But should the eye be converged so strongly as to place the secondary abductors on a "dead center," they have no power whatever of aiding abduction. In the mode of action of the secondary adductors and abductors we have the cause for the tendencies for squint to become constant, and for constant squint to become extreme.

In convergent squint, the abnormal contraction is quite as much in the nasal fibers of the superior and inferior recti as it is in the internus. No operative treatment of convergent squint can be regarded as rational which does not attempt to correct this essential abnormality. Simple tenotomy and advancement are radical only as concerns the internus and externus. As regards the more important factor, the contraction of the nasal portion of the superior and inferior recti, they have only a secondary influence through change of function.

From the early days of tenotomy the uncertainty of the result in any given case has been noted. In a large proportion of cases the squint, apparently corrected at the time, would recur; or later divergence would replace the convergence. It looked as if Nature, instead of helping to bring about the normal direction of the eyes, was determined to prevent it. This is explained by the tendency of the secondary adductors and abductors to turn the eyes even farther outward or inward. Simple tenotomy lessens the influence of the primary adductors and abductors; and to that extent abandons the eye to the influence of the secondary (or normally accessory) adductors and abductors. It lessens the influence of those forces which tend to come to equilibrium with the eyes in or near the primary position; and it increases the relative influence of those forces which tend to turn the eye away from the primary position. As compared with such an operation, advancement, which tends to increase the influence of the primary abductors and adductors, is decidedly more rational. If convergent strabismus is to be regarded as organic and attacked by operative procedures, it is proper to direct these procedures to the most serious alteration of structure, the contraction of the nasal margins of the superior and inferior recti. It would seem reasonable to divide these, even though the internus be left untouched, or only well stretched.

The operation which undertakes to do this I described last year.[1] It may be understood from an inspection of Figure 5, in which the opening of the conjunctiva and the insertions of the internus are shown at A and the insertions of the inferior and superior recti at B and C. The portion of the tendon insertions to be divided are indicated by broken lines; the part of the insertions to be left standing, by solid lines. This operation is to be done only for high degrees of squint. For lower degrees the internus should be left uncut, or simply an advancement practiced. In very high degrees, as mentioned last year, the extended tenotomy may be combined with advancement.

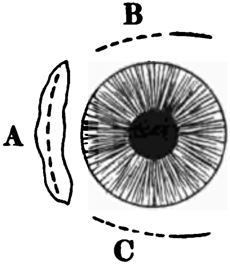

Figure 5.

In the case reported above, there was the very unusual combination of high comitant convergent squint of long standing, with capacity for full binocular vision. This capacity contributed to the perfection of the result. It may be noted, however, that there remains, with orthophoria for distance, exophoria of 8 centrads for near work. This is a condition found in many people who have reached this patient's period of life. But it is one that would be naturally connected with the conditions established by tenotomy of the accessory adductors. It is a lessened power to execute and sustain a high degree of convergence. The possibility of establishing this condition should be considered in planning such an operation; but such exophoria would be of no practical importance except in a patient gaining good binocular vision.

## SUMMARY.

The case here reported illustrates the permanence of the results obtained by extended tenotomy. The primary adductor and abductor, the internus and externus tend to equilibrium with the eye directed forward. The secondary adductors (the superior and inferior recti) and the secondary abductors (the obliques) tend to turn the eye ever more strongly in or out. A rational operation to correct excessive convergence must tend to lessen the relative influence of the secondary adductors.

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1906.

# A STUDY OF CONVERGENCE AND ITS DEFECTS.

## INCLUDING AN ANALYSIS OF FOUR HUNDRED AND FORTY-ONE CASES OF EXOPHORIA.*

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Next to the visual act itself, convergence is admittedly one of the most interesting of the functions of human eyes. That it is evolutionally the last oculomuscular function to appear seems now equally well admitted. The gradual evolution of the invertebrate eye is scientifically satisfactory. The transition from the invertebrate to the vertebrate eye is involved in some doubt. From that point upward, however, the evolution is resumed and continues very regularly. In the lowest class of vertebrates (the fishes) the eye is probably no better than a squid's. Their eyes are situated on the side of the head with such widely divergent axes that there is no overlapping of the visual fields at all. There is no consensual movement (each eye being absolutely independent of the other). There is no common field of view, no common point of sight, no corresponding points in the two retinas; hence no stereoscopic vision. Leaving out amphibians and reptiles of which we know little, in birds binocular vision becomes possible by a unique arrangement of corresponding points about a very excentral fovea, though their optic axes are widely divergent. In mammals the optic axes are brought around more and more to the front, the convergence of the axes on a point of sight becomes easier and easier. With this comes the gradual development of corresponding points about a more highly organized central area; hence all the phenomena of stereoscopic vision and the judgments based thereon.

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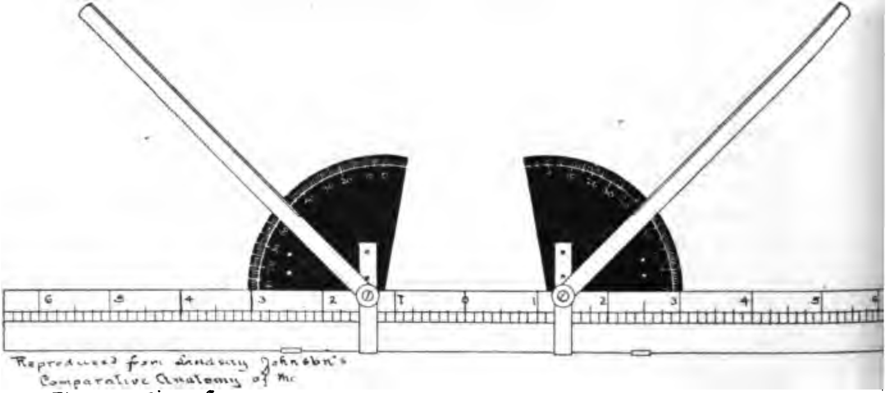
* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

Only in the anthropoid apes do we find the eyes fairly in front with optic axes parallel in the position of rest. There is, too, a much more highly organized spot of central vision (fovea) added, which is the essential basis of what the psychologist calls attention.

Out of all this there came thoughtful attention to the object under observation—to the partial exclusion of other things—which seem a necessary condition to the emergence of the higher faculties of the mind. The existence of the fovea is necessary to the concentration of attention on the thing looked at, for, as Le Conte says: "How could we attend to one thing if all other things were equally distinctly seen?"



Reproduced from Lindsay Johnston's
Comparative Anatomy of the
Mammalian Eye

GONIOMETER
Figure 1.

Harris[1] finds that in all vertebrates below mammals there is a total decussation of the optic nerves at the chiasm. In this connection the magnificent work of Lindsay Johnson[2] is of profound interest. Each time he investigated the fundus oculi of the more than 200 different animals that came under his observation he measured the divergence of the optic axes by means of a special contrivance known as a goniometer. This instrument (Fig. 1) consists of a bar on which graduated quadrants slide, each carrying a movable indicator revolving on it. To measure the divergence of an animal's eyes the instrument was placed on its head immediately

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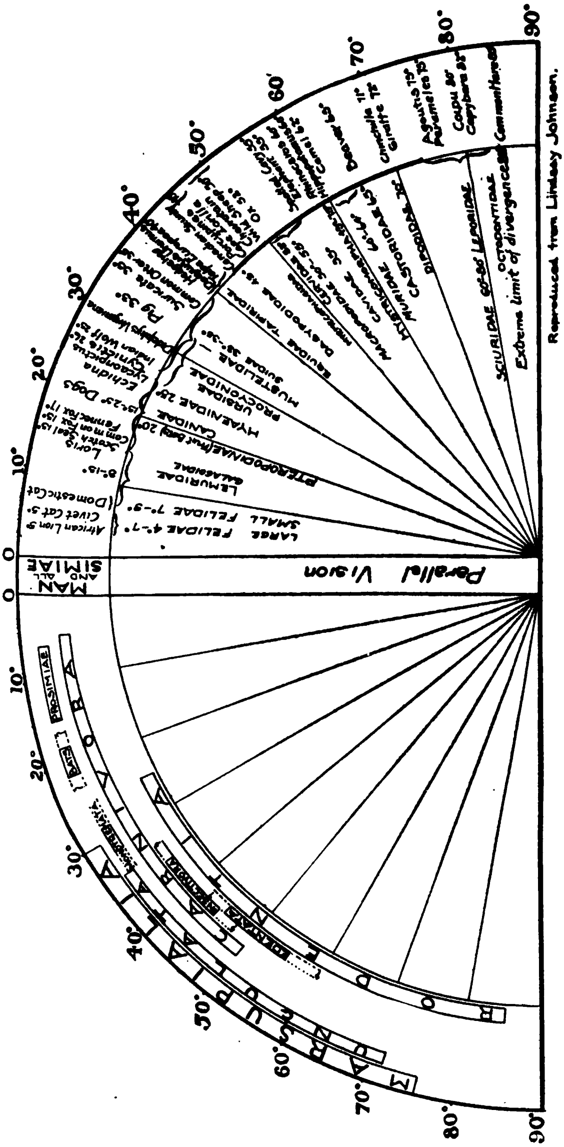
[1] Brain, vol. xxvii.

[2] "The Comparative Anatomy of the Mammalian Eye," London, 1901.



Reproduced from Lindsay Johnson.

Diagram showing the divergence of the optical axes in the Mammalia.

The Natural Orders are represented on the left-hand quadrant, the Families, Genera and Species on the right.

Figure 2.

above and parallel to the plane passing through the centers of the two eyes. The quadrants were moved so that the pivots of the indicators (a) lay in the axes of the two eyes. The indicators were then rotated on their pivots until the indicators themselves lay directly in the line of the two optic axes. The number of degrees thus obtained indicated the deviation from the median line or, in other words, from parallel vision. If the indicators stood at right angles to the median line the divergence would equal 90 degrees; if parallel to the median line, the divergence would equal zero. The results of this colossal task are shown in Figure 2 taken from his work.

On the left hand of the chart will be found the range of divergence between the various members of the orders taken as a whole, while on the right details as to families and genera are given. It will be readily seen from the chart that the higher the order the nearer the axes approach parallel vision, although the range in each is considerable, and each one to some extent overlaps the other. It will also be noted, on the right hand of the chart, that the degree of divergence in each eye for the hare is 85 degrees, for the giraffe 72 degrees, for the porcupine 45 degrees, for the hedgehog 40 degrees, for the pig 33 degrees, for the wolf 25 degrees, for the dog 20 degrees, for the fox 15 degrees, for the cat 10 degrees, for the lemur about 5 degrees and for the monkeys and apes, as also in man, zero or parallism of the optic axes.

In the development of the human embryo there can be followed the same evolution in one species that is above outlined in all the vertebrate. The eyes develop on the sides of the head as in the fish. Gradually with the formation of the face they are brought around to their permanent frontal position and are in place about the end of the second month. In this the ontogeny agrees with the phylogeny, and the forward rotation of the orbits of each vertebrate is consistently followed in the developing human embryo (Pohlmann). During the rotation of the eyeball to the front the orbits also become less divergent until in man the inner walls of the two orbits are parallel and in relation with the nasal fossæ. The outer wall describes an angle of about 40 degrees to the inner, giving an orbital axis in the human being of about 20 degrees divergence from the median plane of the head.

The stimulus to the animal to see what is directly in front of it attains its highest development in man and the anthropoid apes. Man, however, carries the matter still farther and develops what "at one time amounted to an inco-ordination of the eye muscles to enable him to see things which are close by with both eyes" (Pohlmann). The monkey can maintain only a limited convergence for a short time and man is the only animal with sustained convergence. As civilization progressed, near work became more and more absolutely necessary and convergence became less an effort and more of an automatic act. With the invention of the printing press, the amount of near work imposed on the eye increased manifoldly and to-day we use our eyes largely as "contact organs."

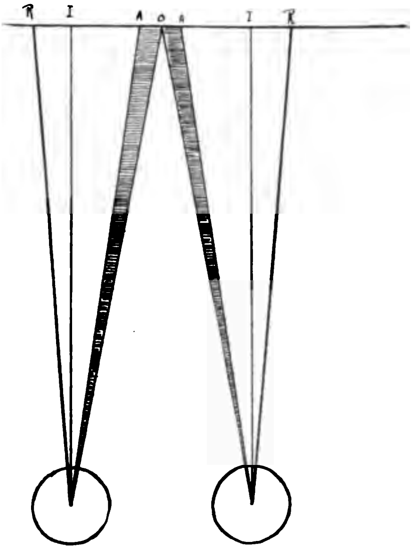


Fig. 3.—(After Maddox). R, Punctum emotum. R. I., initial convergence. I. A, accommodative convergence. A. O, reflex convergence.

ANALYSIS OF THE ACT OF CONVERGENCE.

Inasmuch as convergence and divergence are parts of the same act, it may be well to ask, with Maddox, "What is the starting point of convergence?" If the innervation of the eyes were temporarily inhibited, the eyes would surely take up a position of about 20 degrees' divergence, as claimed by Hansen Grut.[3] Le Conte[4] has shown that during sleep, and in his own case during drowsiness, the eyes diverge, as they also do in drunkenness, under anesthesia and at death. Prentice,[5] believing that the postmortem findings might shed light on the real anatomic position of the eyes, tabulated the conditions in 3,000 cases within from 24 to 48 hours after death, and in not one did he find the eyes straight. In 17 persons who had parallel ocular axes during life, he found divergence postmortem. He concludes, therefore, that even in civilized man there is a tendency toward divergence which is overcome by fixed innervation. This fixed innervation is what Maddox[6] calls tonic or initial convergence.[7]

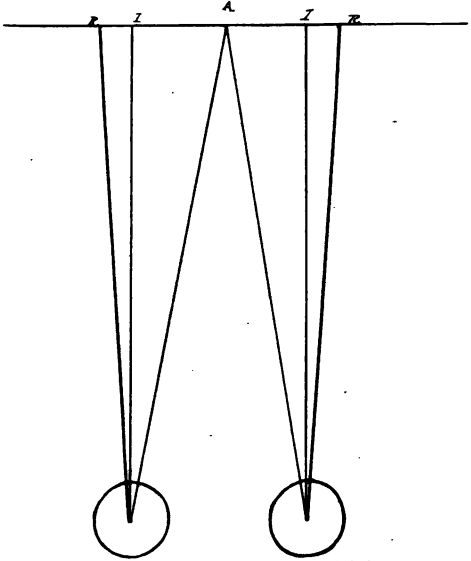


Fig. 4.—R, punctum remotum. R. I., initial convergence (tonic convergence) ; I. A., accommodative convergence.

In Figure 3 he represents convergence as composed of three elements: the initial or tonic element, the accommodative element, and the reflex element, although exception might be taken to the latter element. It is simpler to resolve convergence into two elements, namely, initial or tonic convergence (the phylogenetic convergence of Pohlmann) and accommodative convergence (Fig. 4). This, however, is the academic phase of the matter. Landolt approaches the subject of convergence in a much more practical fashion and shows how deeply he feels that it is a problem sufficiently often encountered in the flesh to merit our earnest study. He prefers to measure the amplitude of convergence, because of his conviction that that is the key to many otherwise puzzling anomalies of convergence. He, therefore, estimates the punctum remotum of convergence by finding the greatest prism base in that can be overcome (prism divergence). For rough calculation, this may be divided by 7 and the approximate degree of negative convergence (or divergence) in meter angles thus obtained. For instance, if prism divergence be 7, there is one meter angle of negative convergence. For estimating the positive convergence, prisms are not of sufficient value, because of the varying quality of convergence so estimated. His preference is for the ophthalmodynamometer (of his own contrivance). For this purpose I have for three years employed what seems to me a much simpler device. Using the one-candle electric light of the DeZeng electric ophthalmoscope, I half-darken the room and then, starting at 15 inches from the face, have the patient watch the light attentively as it is carried in the median line toward the eyes. At about 10 inches from the eyes the corneal images from the electric light become plainly visible to the surgeon, and it is then easy to watch these images as the light is carried toward the root of the patient's nose until one or the other of the corneal images comes to a standstill. This is the near point of convergence, and one can readily calculate the number of meter angles of positive convergence at the patient's disposal. For instance, if one of the corneal images comes to a standstill at 4 inches, there are 10 meter angles of positive convergence; if at 5 inches, there are 8 meter angles; if at 3 inches, there are 13 meter angles. The test as thus applied is objective, while Landolt's procedure is subjective and open to all the disadvantages of every subjective test. This test is applied in about 5

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[3] Knapp's Archives, vol. xxiv.

[4] "Sight," p. 254.

[5] Lancet, 1899.

[6] "The Clinical Use of Prism," Bristol, 1897.

[7] Hansen Grut aptly compares it to the tonic element in the accommodation of a hypermetrope.

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8. Norris and Oliver: "System of Diseases of the Eye," vol iv.

seconds, as a rule.[9] The amplitude of convergence is, hence, the sum of the positive and negative convergence. Thus if there be 9 degrees of prism divergence (1.28 meter angles of negative convergence), and the corneal images come to a standstill at 4 inches (10 meter angles of positive convergence), the total amplitude = 1.28 + 10.00 = 11.28 meter angles of convergence.

By the above test I have found that the average patient converges to 4 inches (10 centimeters) without any difficulty (= 10.00 meter angles), and, as the average patient has somewhere near 7 degrees of prism divergence[10] (1 meter angle of negative convergence), the average amplitude as I have found it in my office is about 11 meter angles. Landolt has found 10.50 as his average. He has further shown[11] that of the total 10.50 to 11.00 meter angles the reserve ought to be about twice as great as the convergence required by the work, and that is about what occurs in the average individual. Most work is done at about 13 inches from the eyes, that is, it requires about 3 meter angles of convergence, and this leaves from 6 to 7 meter angles in reserve, or a trifle more than twice as much as the ordinary amount used. If there be much departure from this relation, there is almost sure to be some discomfort in the use of the eyes at the occupation distance. As these two tests —estimation of the prism divergence and estimation of the convergence near point—can be accurately executed in from 3 to 4 minutes, there can be little excuse for omitting them in any patient with exophoria who has not been made comfortable by the use of a non-prismatic correction only. Indeed, I believe it wise and valuable to make them in all cases of exophoria before dismissing the patients to try the effect of their proper correction.

## ANALYSIS OF FOUR HUNDRED AND FORTY-ONE CASES OF EXOPHORIA.

In the analysis of the following 441 cases, these facts are to be borne in mind:

1. All of the cases occurred in private practice.
2. Only cases presenting stereoscopic vision have been included in the analysis (hence exotropia is excluded).

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[9] It is also worth while in pursuing this test to approach the light from the right and left side as suggested by Duane.

[10] In 60 consecutive cases of exophoria it was found to be 7.5 degrees.

[11] Arch. Opht., March, 1886.

3. Proper correcting lenses were prescribed by me and tried thoroughly before proceeding to the treatment of the exophoria as an intrinsic condition, or the patients had been recently refracted by a trustworthy ophthalmologist.

4. No selection of cases for these statistics has been made. They have been taken consecutively and include all the cases of exophoria I have seen in private practice.

5. Refraction with a mydriatic was done in practically every patient under 45 years of age when I did the refraction myself. Over that age the refraction was done without a mydriatic.

6. In testing for exophoria at the near point, the dot and line test was discarded entirely, first, because it places the eyes under highly artificial conditions; second, because many women (and the bulk of these patients were women) can not tell whether objects are in alignment or not.

Instead of the dot and line, the Maddox multiple rod was used, along with the one-candle electric lamp used on the DeZeng electric ophthalmoscope (described above in connection with the convergence near-point test). This little light the patient holds at the ordinary occupation distance (about 13 inches), and by means of the multiple Maddox rod great delicacy is secured, one-fourth of a degree of error being easily thus revealed. In presbyopes the reading correction should be used when this test is applied or the observer will be led into error. Schild's, Baer's or any other development of the simple apparatus I have described may be used, but for six years I have found the simple one-candle electric light and the Maddox rod satisfactory in every way.

7. In testing prism divergence (abduction) and prism convergence (adduction) separate prisms were used, the prism divergence being always estimated first. In obscure cases the following 7 points were considered essential to a proper study of the case: (a) The exophoria for infinity (or distance); determined by both the cover test and the multiple Maddox rod.[12] (b) The hyper-

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[12] The cover test seems to me one of the most valuable tests at the ophthalmologist's service if applied as follows: The patient is made to survey some small object on a homogeneous background (like a blank wall or a small point of light looked at in a mirror across the room; by reflecting the light in this way a good distance can be obtained for the test). With the patient's gaze fixed on the fixation object, a card is carried in front of the eyes from right to left, covering first one eye and then the other. This

phoria for infinity. (c) The prism divergence (abduction). (d) The prism convergence (adduction). (e) The exophoria for 13 inches (33 centimeters). (f) The hyperphoria for 13 inches (33 centimeters). (g) The convergence near point.

These seven maneuvers may be accurately gone through in from 6 to 8 minutes and are well worth systematic employment in every obscure case of exophoria in which symptoms persist in spite of the best refraction.

*Age.*—The frequency of exophoria in the various decades of life is given in Table 1, which shows plainly the influence of age in its production. The occurrence of less than one-tenth of all the cases before the twentieth year is a significant fact. Weiss[13] calls attention to the outward swing of the orbits (and along with them their long axes) after puberty. Duane[13] notes those cases in which divergence has developed as a result of the gradual divergence of the orbits taking place during the period of growth in children and youth. "This divergence, by altering the angle of insertion of the tendons and the amount of tendon in contact with the eyeball (contact arc), increases very greatly the power of the externus and diminishes that of the internus, and in itself is quite sufficient to account for the development of divergent strabismus." If it will give rise to so pronounced a deviation as divergent strabismus, it may well be asked: How much more easily may it give rise to a latent deviation or exophoria?

TABLE 1.

| Decade. | No. of times found. | Decade. | No. of times found. |
|---|---|---|---|
| Under 10 | 6 | 41 to 50 | 124 |
| 11 to 20 | 34 | 51 to 60 | 59 |
| 21 to 30 | 90 | 61 to 70 | 14 |
| 31 to 40 | 106 | Over 70 | 6 |

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maneuver should be repeated from 10 to 15 times to break in *on* the fusion impulse as much as possible, great care being taken that at no time, as the card is being moved, both eyes get a simultaneous view of the object else the point of the test is lost. By attentive observation, the eyes will be seen to give a slight jump in or outward as they are alternately uncovered, unless there be lateral balance or less than 1 degree of error. This test is wholly an objective one, and its objectivity and accuracy give it great value. If it is desired to make the test subjective (by asking the patient after a few movements with the card whether the fixation object appears to jump from side to side as the card is shifted), it is very readily done. So carried out, it becomes the parallax test, and is of the greatest delicacy, one-fourth of a degree of deviation being easily possible of detection in intelligent patients.

[13] Knapp's Arch., vol. xxv.

[14] "Motor Anomalies of the Eye."

*Sex.*—Of the whole number here reported 161 patients were males and 280 females, or a proportion of 6 to 11. That is to say, there were almost twice as many women as men presenting exophoria. These figures accord very well with those furnished by analyses of large numbers of refraction cases (say 1,000 to 2,000)[15] which show that about twice as many women as men apply for refraction in private practice. Women's nervous systems are admittedly less resistant than men's, and it is also probable that women employ their eyes more at the occupation distance than do men. Neurasthenia, too, for many reasons, is much more likely to occur in women than in men. Yet examination of 33 cases of exophoria of the neurasthenic type occurring in this whole series were practically equally divided between the two sexes, 15 of the patients being men and 18 women. It is altogether probable that if the figures could be so extended as to include an equal number of males and females exophoria would be found to occur as often in 1,000 men as in 1,000 women.

TABLE 2.

| | | | |
|---|---|---|---|
| **Students** | 50 | **Farmers** | 3 |
| **Accountants** | 20 | **Merchants** | 11 |
| **Desk workers** | 55 | **Needleworkers** | 40 |
| **Stenographers** | 15 | **Salespeople** | 7 |
| **Professional people** | 92 | **Storekeepers** | 8 |
| **Outdoor workers** | 7 | **Housewives** | 120 |
| **Laborers** | 3 | | |
| **Mechanics** | 10 | **Total** | 441 |

*Occupation.*—Table 2 has to do with the occupation of the 441 exophorics. These workers may be arranged in three groups as follows:

1. Those who use their eyes at the occupation distance most of the day.
2. Those who use their eyes little or not at all at the occupation distance.
3. Those whose days are fairly well divided between general work and near work, e. g., housewives.

Thus the students, accountants, desk workers, stenographers, professional people, needle workers (including loomworkers) show a total of 272; the outdoor workers, laborers, mechanics, farmers, merchants, collectors, salesmen, shopkeepers, etc., show a total of 49, while the housewives number 120. In other words, practically two-thirds of the whole number of exophorics were what might be called near workers. I am inclined to attach some importance to these particular figures; for if one be engaged more or less all day in near work, even though they wear a perfect correction, they are very likely to have some symptoms of discomfort at their work if they present exophoria for infinity; in my experience exophoria at infinity generally means deficiency either in the amount of convergence or in the faculty of using it.

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[15] See Risley and Thorington, Jackson, Gould, Ellis and others.

TABLE 3.

| Degrees of Exophoria. | Times found. | Degrees of Exophoria. | Times found. |
|---|---|---|---|
| 1 | 95 | 12 | 4 |
| 2 | 145 | 13 | 1 |
| 3 | 69 | 14 | 1 |
| 4 | 29 | 15 | 7 |
| 5 | 14 | 16 | 1 |
| 6 | 15 | 17 | .. |
| 7 | 9 | 18 | 3 |
| 8 | 9 | 19 | .. |
| 9 | 2 | 20 | 1 |
| 10 | 12 | 25 | 1 |
| 11 | 1 | | |

The degree of exophoria occurring in these 441 cases is shown in Table 3. As in hypermetropia, so in exophoria the smaller degrees of error predominate; the parallel is further borne out by the fact that, as a rule, the smaller deviations carry with them the most marked symptoms, and for the same reason, that they are overcome all day long. Of the whole series of 441 cases, 309, or 70 per cent., were of 3 degrees and under. Only 32 times, or in 41 per cent., did the deviation amount to 10 degrees or more. In 7 cases it reached 15 degrees, in 3 cases 18 degrees, in one case 20 degrees, and in one other 25 degrees. Naturally, these last few were practically instances of suppressed (or overcome) divergent strabismus (anatomic exophoria), which will be alluded to later.

TABLE 4.

| | | |
|---|---|---|
| In 441 cases of exophoria there was associated: | | |
| H + ah in | 176 cases. | |
| Ah in | 34 cases. | |
| H in | 46 cases | |
| H + Ah (one eye) H or Ah (other eye | 46 cases. | |
| Ahm in | 17 cases. | |
| Total for H + Ah and allied conditions | 319 | 319 |
| There was associated: | | |
| M + Am in | 48 cases. | |
| Am in | 16 cases. | |
| M in | 3 cases. | |
| M + Am (one eye) M or Am (other eye) | 7 cases. | |
| Amh in | 16 cases. | |
| Total for M + Am and allied conditions | 90 | 90 |
| There was associated antimetropia: (So-called anisometropia) in | 32 cases. | 32 |
| Total | | 441 |

*Refractive Status.*—We next come to the relation that exophoria bears to the various states of refraction as set forth in Table 4. Despite the fact that exophoria has been looked on by many authorities as a passive condition, it will be seen by reference to the table under consideration that this belief is no longer tenable. That a certain small percentage does represent a passive or under-action phenomenon (in reality an accommodative exophoria) is a well-established fact. But Table 4 shows at a glance that in 441 cases this anomaly was associated with hypermetropia or its allied refractive conditions (H + ah-ah-ahm + H) 313 times, or in 72 per cent. of the cases. And inasmuch as all hypermetropic conditions call for excessive accommodation (hence associated excessive convergence impulse), we may be sure that a certain portion of latent exophoria is masked in such cases by the attempt on the part of the patient to overcome the hypermetropia. Herein lies the unwisdom of anything like a full correction of the spherical element in the hypermetropia associated with exophoria.

Myopia and its allied condition (Am, M + Am, Amh) were present in 89 of the 433 cases (20.5 per cent.) and it is probable that a certain proportion of these were accommodative exophorias.

There remain to be considered 31 (or 7.5 per cent.) cases of antimetropia (the so-called anisometropia) in which it will be later shown that the average degree of exophoria was higher than in any other refractive condition.

*Subdivisions of Exophoria.*—The term exophoria, while of great clinical convenience, is not altogether sufficient to the purpose for which it is employed, in that it gives no clew to whether convergence be deficient, divergence excessive, or the two conditions coexistent. So that, for purposes of statistical study and better understanding of the cases, it becomes necessary further to subdivide a proportion of the series herein offered into:

1. Exophoria with normal divergence and deficient convergence.
2. Exophoria with divergence excess.
3. Exophoria with convergence and divergence both deficient.

These may be, for greater convenience, put down as: (a) Asthenic exophoria (Savage), true convergence insufficiency; (b) sthenic exophoria (Savage), anatomic exophoria; (c) neurasthenic exophoria.

In the series of cases here offered there were 200 in which there was only partial or no relief to the patients' symptoms afforded by correcting lenses alone. Of this latter number there were 121 in which the prism convergence and the prism divergence were estimated in the further study of the cases. Arranging these 121 according as they showed subnormal, normal or excessive divergence, we find the following:

Thirty-five times, divergence and convergence were subnormal; 23 times, divergence was normal and convergence was subnormal; 63 times, divergence was excessive and convergence subnormal. Or to tabulate them more in detail:

TABLE 5.

| Conditions. | No. of Times Found. | Average Exophoria for Infinity. | Average Prism Convergence. | Average Prism Divergence. |
|---|---|---|---|---|
| Neurasthenic exophoria | 35 | 1.80° | 9° | 5.5° |
| Asthenic exophoria. . . | 23 | 2.25° | 11° | 7° |
| Sthenic exophoria. . . . . | 63 | 3.00° | 14° | 8° |

This table shows that over 60 of the class so studied proved to be sthenic or intrinsic exophorias (divergence excess of Duane), a proportion that, it is thought, will hold for the whole series. It further shows that the average exophoria increases as the prism divergence increases (as would naturally be expected). Finally, it sustains Seabrook's claim that exophoria for infinity almost invariably means subnormal convergence, whether the exophoria is asthenic, sthenic or neurasthenic. The influence of hyperphoria in reducing both prism divergence and prism convergence is well known, and no case of exophoria should be put down as neurasthenic until hyperphoria of three-quarters of a degree or more has been excluded. Table 6 was drawn up for the purpose of comparing at every point 6 cases each of neurasthenic, asthenic and sthenic exophoria.

Several interesting practical points are brought out by this table. It is commonly accepted that from 10.50 to 11.00 meter angles of convergence amplitude are sufficient for comfortable work at the near point; and yet in Cases 5 and 6 of Group 1 in Table 6 there was exophoria of 8 degrees for the reading distance in both cases, with a convergence amplitude in one case of 12.00

m.a. and in the other 13.85 m.a. In Cases 1 and 4 of Group 2, there was exophoria of 12 and 10 degrees, respectively for the reading distance, with a convergence amplitude of 21.00 m.a. (!) in each case. It will be readily seen that, while all 4 of these patients possessed convergence amplitude much in excess of what is generally considered quite sufficient, they had all learned the trick of using the power that was potential in their adducting muscles all the time.

Contrast with these Patient 5 of Group 2, who presented an exophoria of 2 degrees for both distance and near work, in spite of the fact that her convergence The foregoing 5 cases illustrate well the value of esti- amplitude was but 8.50 m.a. Here was a patient who, though her convergence amplitude was not all that it should be, yet held her adductors up to their work almost perfectly, for she was almost without symptoms. Too, she was one of those individuals who have themselves well in hand and accomplish all things well; moreover, her physical condition was superb.

TABLE 6.

| | | Exophoria for distance. | Exophoria at 13 inches. | Difference between infinity and near exophoria. | Prism convergence. | Prism divergence. | Convergence near point. | Amplitude of convergence in meter angles. |
|---|---|---|---|---|---|---|---|---|
| Group 1:* | | | | | | | | |
| Neurasthenic. | 1 | 2 | 6 | 4 | 7 | 6 | 3 | 13.85 |
| | 2 | 1 | 5 | 4 | 8 | 6 | 3 | 13.85 |
| | 3 | 1 | 5 | 4 | 8 | 6 | 3 | 13.85 |
| | 4 | 1 | 2 | 1 | 10 | 6 | 3 | 13.85 |
| | 5 | 1 | 8 | 7 | 6 | 5 | 3½ | 12.00 |
| | 6 | 1 | 8 | 7 | 10 | 6 | 3 | 13.85 |
| Group 2:† | | | | | | | | |
| Asthenic. | 1 | 2 | 12 | 10 | 10 | 7 | 2 | 21.00 |
| | 2 | 1 | 5 | 4 | 12 | 7 | 3½ | 12.50 |
| | 3 | 3 | 12 | 9 | 10 | 7 | 4½ | 10.00 |
| | 4 | 3 | 10 | 7 | 11 | 7 | 2 | 21.00 |
| | 5 | 2 | 2 | 0 | 12 | 7 | 5½ | 8.50 |
| | 6 | 1 | 6 | 5 | 14 | 7 | 4½ | 10.00 |
| Group 3:** | | | | | | | | |
| Sthenic. | 1 | 2 | 7 | 5 | 18 | 10 | 3½ | 13.00 |
| | 2 | 12 | 19 | 7 | 20 | 14 | 5 | 10.00 |
| | 3 | 2 | 2 | 0 | 19 | 8 | 3 | 14.15 |
| | 4 | 8 | 15 | 7 | 8 | 9 | 4 | 11.30 |
| | 5 | 5 | 18 | 13 | 18 | 12 | 4 | 11.70 |
| | 6 | 4 | 16 | 12 | 11 | 9 | 4 | 11.30 |

* Cases with subnormal prism divergence.

† Cases with normal prism divergence (= 7 degrees).

** Cases with excessive prism divergence.

The following 5 cases illustrate well the value of estimating both the exophoria for the near point and the amplitude of convergence—for if the exophoria for the near point be much greater than that for infinity and the convergence amplitude be normal—the necessity for convergence training, with prisms or otherwise, is apparent. Such patients need to be shown how to use a faculty they already possess. On the other hand, when exophoria for the distance shows no increase when estimated for the near point, though the convergence amplitude be normal or even above normal, not so much need be expected from further training of a faculty the patient already knows how to use and is probably drawing on heavily.

A word as to the proportional relation between prism divergence and prism convergence. In 1895, Risley[16] stated his belief that muscular asthenopia frequently proceeded from disturbance between the relation of adduction to abduction which should be as 3 to 1. This was based on results obtained with the rotary prism. Some time earlier Noyes had spoken of 5 or 6 to 1 as the normal relation. Following Risley, Bannister[17] went over 100 U. S. Army recruits and, using separate prisms from the trial case, came to the conclusion that "there exists in healthy eyes no positive definite relation between prism convergence and prism divergence for distance, and that it is not correct to claim that such eyes should, without practice with prisms, show at 6 meters a ratio between these functions of 3 to 1 or 6 to 1 in favor of convergence, not permitting abduction to fall below 6."

Naturally, much depends on the way in which the tests are applied. Convergence is a variable elastic quantity. Prism divergence is a fairly constant one. It would seem wise, therefore, first to test the prism divergence, gently leading the patient along by having him close his eyes from time to time and open them suddenly, with the purpose of arriving at his greatest possible prism divergence, then closing and resting the eyes for a few minutes before estimating the prism convergence. This was the method employed in the subjoined series of 121 exophorics in whom it was found that: prism divergence was in excess 12 times; prism divergence and prism convergence were equal 10 times;

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16. Univ. Med. Mag., 1895.
17. Annals of Ophth., 1898.

the relation of prism convergence to prism divergence was as 1½ to 1, 30 times; as 2 to 1, 41 times; as 2½ to 1, 19 times; as 3 to 1, 7 times; as 4 to 1, twice.

Bannister's figures appear to be very good ones to work from, as they are based on methods largely in use in ophthalmic offices the country over. As compared with them, it will be seen that in exophoria the relation of prism divergence and prism convergence varies in so confusing a manner as to attach little value to their relative behavior. Estimation of the near point exophoria and convergence near point are more essential. Necessarily the amount of prism convergence in a case of exophoria is always of interest; for instance, if a patient's distance vision begins to blur when a 6, 8 or 10 degree prism is placed base out before the eyes, the inference that their prism convergence is defective and that they have not learned to dissociate their accommodation and convergence is entirely justifiable.

In Table 7 the average exophoria in the various states of refraction is shown and we here find food for thought:

TABLE 7.

| | | Average exophoria. |
|---|---|---|
| H + Ah and allied conditions..... | 319 cases. | 2.5 degrees. |
| M + Am and allied conditions.... | 90 cases. | 3 degrees. |
| Ahm ........................ | 17 cases. | 3 degrees. |
| Amh ........................ | 17 cases. | 4 degrees. |
| Antimetropia .................. | 31 cases. | 5 degrees. |

In H + Ah as it commonly occurs, stereoscopic vision is usually very little, if any, hindered, and the average exophoria associated with it is but 2.5 degrees. In antimetropia (the so-called anisometropia) where dioptric inequality between the two eyes ofttimes interposes a weighty hindrance to smooth, easy stereoscopic vision, the average exophoria rises to 5 degrees. In other words, when there is sufficient obstacle to the performance of stereoscopic vision, the eyes tend toward the position of anatomic rest, which is a heritage to us from our forebears for countless generations. Exophoria thus reveals itself as a reversion to a lower type and may justifiably be considered an atavistic phenomenon, as claimed by Lindsay Johnson, Pohlmann, LeConte, Jackson and others. The data here given lend firm statistical support to that contention.

As to symptoms, 200 of the 441 cases here catalogued presented symptoms of muscular asthenopia persisting after careful correction of their refraction. Of these two hundred, 173 exhibited headache, the frontal type predominating in 102, the occipital in 60, the temporal in 11; while 140 gave testimony as to more or less vertigo, especially after near work. Ocular fatigue and ache were present in 153, ocular tenderness in 98, conjunctival irritation was complained of in 121, low-grade photophobia in 130. Nausea seemed fairly well related to the exophoria 72 times; and drowsiness after near work was almost invariable, as was also picture-gallery and after-shopping fatigue. Gastric reflexes seemed etiologically related to the exophoria in 23 cases in an unmistakable way. By gastric reflex is meant the nameless vacant sensation in the epigastric region so perfectly described by DeQuincey in his "Confessions." That a certain proportion of exophorics (who overcome their exophoria) have this reflex is indisputable. Two cases presented intractable superior dental neuralgia (with teeth in the most perfect condition) that yielded to prisms, bases in, for permanent use. Another case exhibited the complete picture of acute glaucoma that subsided within three days after the incorporation of prisms, bases in, in distance correction.

*Treatment.*—The treatment of exophoria calls for about as nice discrimination as any problem in medical practice.

First of value, I would place right living, hydrotherapy and abundant sleep; second, the most painstaking refraction; third, convergence training. This may be of various kinds, but I have resorted mainly to two kinds, namely, converging exercises on a pencil from arm's length in toward the root of the nose until the convergence near point is reached and the patient sees double. This was invariably prescribed to every exophoria. Pencil converging exercises to the left and right (as suggested by Duane) was of service in a few cases.

The second element in convergence training is by means of prisms, bases out, according to the method popularized by Gould as "weighting the convergence stimulus." The patient is given a pair of 5-degree prisms in a frame with which he walks toward a candle flame, placed at the far side of the room. The prisms are raised as he goes toward the light. As soon as he reaches it, the prisms are dropped before the eyes and he backs away from the light, gazing steadily at it all the time. Should the light be seen double, the patient immediately retraces his steps and again backs away from the light until he goes the entire length of the room, holding the candle light single. This is done from ten to fifteen times, two or three times daily. After a week, 10-degree prisms are ordered to be used in the same way; in another week or two, 15 degrees or 20 degrees according as the patient rapidly or slowly learns the trick of dissociating his accommodation and convergence. This method is of value in all exophorics.

Prism exercises were resorted to in this manner in 147 of the 200 cases as the sole optical treatment aside from the wearing of a proper correction; in 26 more the exercises were employed in connection with the use of prisms, bases in, in the patient's distance correction; and in 27 more in connection with the use of prisms, bases in, in the patient's reading glasses.

*4. In Prisms, Bases In, for Permanent Use.*—The use of prisms, bases in, to be incorporated in the patient's distance correction, has been deprecated by various high authorities. Their chief (and almost unanimous) contention has been that the exophoria for infinity increases under the use of such prisms. That this is true, within certain limits, must be admitted; and yet in anatomic exophoria,[18] when proper correction of the ametropia has failed to relieve, and attempts at training the convergence have been poorly borne, the trial of prisms, bases in, in an extra or hook-front experimentally seems to me entirely justifiable. In cases so selected, it will be found that when convergence has been made somewhat easier to the patient by the use of rest prisms, the convergence may then be trained to a very considerable point, and the convergence for infinity thus kept from increasing. This was my experience in 17 out of 42 cases in which prisms, bases in,[19] were ordered for constant use. It is no more surprising that the exophoria should increase in these cases of anatomic exophoria than that a patient should gradually manifest more and more of a latent hypermetropia as plus lenses are skillfully crowded on his eyes. And I believe there are few cases of anatomic exophoria (due to orbital peculiarities, insertional anomalies, etc.) in which there is not a considerable element of latent exophoria un-recognizable with the Maddox rod because of the overwhelming fusion impulse in such individuals. For such patients I know of no test comparable to the cover test if employed as previously described. It is as wrong to order prisms, bases in, for permanent use without soon after training the convergence to the highest possible point as it would be to rest an inflamed joint and then not exercise it afterward. Many of these patients have a splendidly developed convergence, but it is because of their excessive use of it all day long in overcoming their exophoria that they have their symptoms.

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[18] By this is meant exophoria with highly excessive prism divergence and defective temporal arc rotation. (The "Divergence Excess" of Duane; or the "Intrinsic Exophoria" of Savage).

[19] Minus prisms Maddox prefers to call them.

A class of patients for whom convergence training is even more plainly indicated are the exophorics who present but 1 or 2 degrees of deviation for infinity with anywhere from 10 to 15 degrees' deviation at the reading distance (prism divergence being normal). These patients respond finely to convergence training as a rule. There is, however, a small outlying percentage in whom it will be found necessary to supplement convergence with prisms, bases in, in their reading glasses only (these patients are mainly presbyopes) before they become entirely comfortable in near work. In 45 patients for whom prisms, bases in (or decentered lenses), were used, there were ordered prisms correcting one-quarter of the infinity exophoria in five cases; one-half of the infinity exophoria in eight cases; two-thirds of the infinity exophoria in ten cases; the full amount of the infinity exophoria in ten cases; more than the full amount of the infinity exophoria in twelve cases, with uniformly good results.

There may be room for doubt as to the wisdom of ordering prisms for constant use, but one need not hesitate to order prisms, bases in, for use in reading glasses only if the divergence for the near point exceeds 10 degrees. From one-third to one-half of the deviation for the near point will usually be gratefully accepted.

### OPERATION.

When it comes to the question of operation in exophoria (after all the preceding measures have failed to relieve) there is the widest variation of views among the writers on this subject.

When exercise of the function of convergence has failed Landolt[8] is devoted to advancements. In Hansell's experience[20] advancement will often permanently cure. Savage and Thomas[21] both indorse muscle shortening as the operation of election when other means have not relieved the patient. Posey[22] did DeWecker's capsular advancement in 33 cases of pronounced exophoria, and states that, although after a lapse of two years there seemed but little objective gain, the improvement in the symptoms was marked and would seem to justify the operation. W. R. Parker,[23] if "driven to operation" (and this ought to be the stand taken by every ophthalmic surgeon—he should feel driven to operation), does tenotomy or advancement according to the indications.

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[20] THE JOURNAL A. M. A., 1895, vol. xxv, p. 745.

In the series here discussed (441 cases) operation was done seven times, and in each instance tenotomy was resorted to. In three cases, the amount of exophoria operated for equaled 10 degrees, in one case 12 degrees, in one case 13 degrees, in one case 18 degrees, and in one case 20 degrees. In two cases in which both externi were equally and moderately divided at the one sitting, there was subsequent homonymous diplopia for three to four weeks, especially in the temporal periphery, but this eventually left the patients with vastly more useful eyes than they had ever had before. All these seven patients were markedly helped by the operation. In each one convergence training (begun from three to seven days after operation) was relied on to finish a cure. Theoretically, advancement is strongly indicated in exophoria, yet in the anatomic variety, with convergence decidedly insufficient and divergence more decidedly in excess, I can see no reason why tenotomy should not be done, first, because there seems no danger of nasty after-results (from five to six years after the tenotomy, such as we see in tenotomics for convergent squint); second, tenotomy is infinitely easier than advancement for these functional conditions and vastly easier of adjustment to the particular condition in each individual, whereas advancement is very much clumsier and more difficult of performance.

In spite of the feeling in some quarters that the stitch by means of which advancement is done is very simple and very easy, I feel disposed to continue doing tenotomies in the very few exophorics (slightly less than 2 per cent.) who need operative help.

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23. Ophth. Rec., 1901.
21. The Journal A. M. A., 1895, vol. xxv, p. 745.
22 Annals Ophth., 1899.

## CONCLUSIONS.

Finally, the following conclusions growing out of twelve years' earnest thought and work with exophoria are offered with all diffidence as to the result of that experience:

1. Exophoria, as a symptom-producing quantity, has come to the point where it must be viewed as an atavistic phenomenon—a reversion to a lower type—a stigma of degeneration, if some one wishes to insist on it. (I do not hesitate to use the latter designation, as I am myself an exophoric.)

2. All the advantages of binocular streoscopic vision are conditioned on convergence only.

3. Convergence as it is daily dealt with may be said to be composed mainly of two elements—the initial or tonic convergence and the accommodative convergence.

4. The amplitude of convergence ought to be always calculated.

5. The average patient has somewhere between 10 and 11 meter angles of convergence.

6. The reserve amount of convergence ought to be about twice as great as the convergence required by the work.

7. The cover test is the most reliable test for study of the position and behavior of the eyes when fixed on an object at twenty feet.

8. When converted into the parallax test much added delicacy is secured.

9. The Maddox rod and a small electric light are much superior, as a test for the muscle balance at the reading distance, to the vertical diplopia test.

10. Nine-tenths of all cases of exophoria will be encountered in individuals over 20 years of age.

11. The frequency of exophoria in the male and female is about equal.

12. Exophoria for infinity generally means deficiency either in the amount of convergence or in the faculty of using it.

13. Low degree exophorias are the most common and the most symptom producing.

14. The average degree of exophoria is least in H + Ah conditions, rises through the M + Am conditions, and is highest in antimetropia.

15. Exophoria assumes three principal forms; i. e., (a) asthenic exophoria (convergence insufficiency), (b)

anatomic exophoria (sthenic exophoria), (c) neurasthenic exophoria.

16. About 50 per cent. of exophorias are of the sthenic or anatomic variety.

17. The test of the muscle balance at the reading distance is no measure of the total converging power of the patient and must be supplemented by tests for the convergence near point.

18. The prism convergence is only of relative value as a working indication.

19. The relation of 3 to 1 as between prism convergence and divergence will not nearly hold in exophoria.

20. The influence of hyperphoria in often reducing the power of both divergence and convergence is well known, and no case of functional divergence should be put down as a pure exophoria until hyperphoria of three-quarters of a degree or more has been excluded.

21. In hyperexophoria the use of suitable vertical prisms, with convergence training, will frequently do away with all the patient's symptoms.

22. The symptoms of exophoria do not differ materially from those of other forms of eyestrain.

23. The treatment of exophoria should comprise (in the following order): (a) Right living; (b) careful refraction; (c) convergence training; (d) prisms (bases in) for infinity; (e) prisms (bases in) for the reading glasses only; (f) tenotomy or advancement.

1212 Spruce Street.

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# SOME AXIOMS CONCERNING OCULAR ROTATIONS.*

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A convex sphere set in a concave hemisphere, the two having a common center, the one fitting in the other as shown in Figure 1, can be rotated on any one of its diameters, and only on a diameter, as an axis. The center of curvature, the point to which all the radii converge, is the center of rotation. The point on the surface at which the force is applied determines what the plane of rotation shall be and fixes the axis of rotation at right angles to this plane. This can be best understood by a study of Figure 1.

A B D represents the concave hemisphere whose center is *c; a d b e* represents the convex sphere whose center is also *c*. If the force is so applied that *a b* shall be the rotation plane, the axis of rotation will be the diameter *d e*; if the force makes *d e* the rotation plane, then the diameter *a b* becomes the axis of rotation. In like manner, if the force makes *m n* the rotation plane, the diameter *h i* becomes the axis of rotation; and if the force makes *h i* the rotation plane, then the diameter *m n* becomes the axis of rotation. The law governing the rotation of a convex sphere lying loose in a concave hemisphere, the two being concentric, is that the force may be so applied as to make the plane of rotation any plane that would divide the sphere into two equal parts; that the axis of any rotation must be a diameter at right angles to the rotation plane, and that the common center of all rotations must be the center of curvature. In such a sphere there is no diameter that must be common to every plane of rotation; hence there is no single plane that must contain the axes of all rotations; but every rotation plane and every axis of rotation must cut the center of rotation which is the center of curvature.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

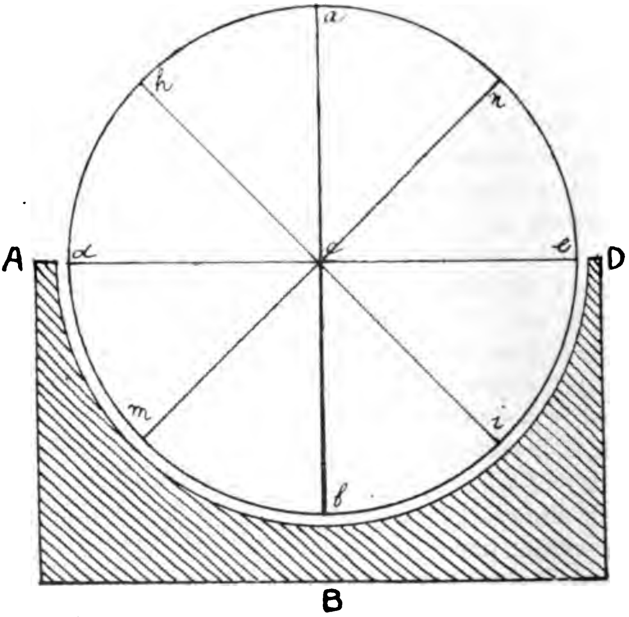

Figure 1.

Figure 2 represents the eye set in its orbit. A B D represents the hemispherical concavity in the bed of fat in which the eye *r d b e* rests. The central point of the macula, *b*, is the point through which all retinal meridians pass; hence it must be the posterior pole; the center of retinal curvature, *c*, is the center of rotation, for through it all diameters pass and only a diameter can be an axis of rotation. The antero-posterior axis—the optic axis—begins at *b,* the center of the macula, passes through *c,* the center of curvature, thence on to *a,* which point, being 180° from *b,* must be the true anterior pole, for through it the completed meridians would cross. The line *b c a* prolonged from *a* would cut the corneal curve, *s r x,* at *r,* and this point, at or near the center of the cornea, may be called the anterior pole

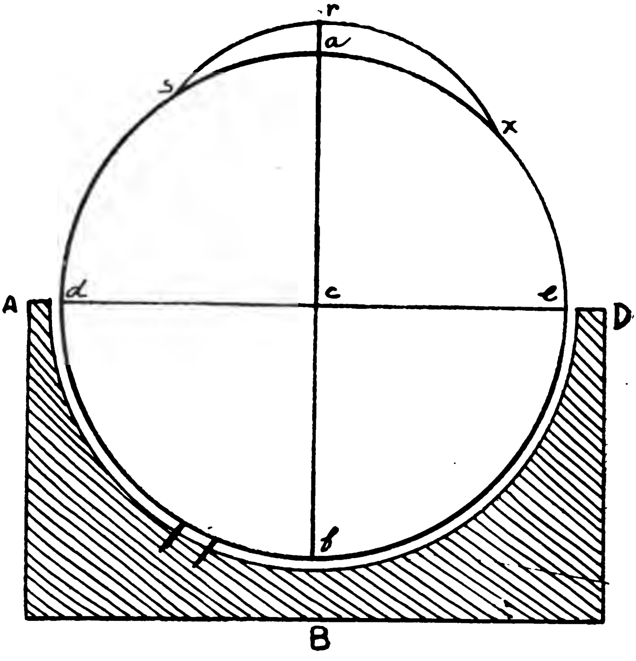

Figure 2.

of the eye, though the real anterior pole, as shown, lies in the aqueous chamber at *a.* The line, *b c a r,* is not only the antero-posterior axis—the optic axis—but it is also the visual axis. The line *d c e* is the transverse axis of the eye and lies in a plane equally distant from the two poles, *b* and *a,* which is the equatorial plane.

Unlike the loose sphere shown in Figure 1, the eye shown in Figure 2 has a single diameter that must lie in every possible rotation plane, and that line is the visual axis *b c a r*. The purpose of every ocular rotation is that the point of view may be changed, that the visual axis may be rotated so as to bring the macula under another image. That this may be done in the shortest time and with the least expenditure of force, the visual axis is made to move in a plane common to the first and second points of view and the center of rotation. The axis of this rotation must cut the center of rotation and must be at right angles to the rotation plane. The visual axis must lie in every rotation plane, whether the rotation is from the primary to a secondary position, or from one secondary position to another secondary position. Since the visual axis lies in the plane of every possible rotation, all rotation planes must cut the two poles, *b a*. Only meridional planes cut the two poles; hence every plane of rotation of the eye is a meridional plane extended. The only plane cutting the center of rotation at right angles to all the meridional planes is the equatorial plane; hence the equatorial plane contains the axes of all possible rotations.

Every rotation plane of the eye is a fixed plane, for in it lie three fixed points, the center of rotation and the first and second points of view. Every point on any corneo-retinal meridian, other than the one which is the plane of a given rotation, is moved in a plane parallel with the rotation plane; hence ocular rotations must be effected without torsioning. This is true whether the rotation is in one of the four cardinal directions or in any oblique direction.

Under the influence of brain centers the ocular muscles effect all rotations. Their number, their origins and attachments are such as to make every rotation take place in a meridional plane, around an axis lying in the equatorial plane. The ideal eye is rotated in the horizontal plane by only one muscle, either the externus or the internus; in the vertical plane by only two muscles;

if upward, by the superior rectus and inferior oblique; if downward, by the inferior rectus and the superior oblique; in any oblique plane by three muscles, two recti and one oblique. If but one muscle is concerned in a given rotation it is because the rotation plane (the extended meridional plane) bisects the muscle from its origin to its insertion. If two or more muscles must act in a given rotation, it is because their combined action would be the same as the action of a single muscle so related to the eye that the rotation plane would bisect it from origin to insertion. With fewer than six muscles rotations of the eye in all directions could not be effected, and a greater number is not needed.

From one to three cortical brain centers are excited in every ocular rotation, and only cortical centers are excited when there is but one eye. Under the control of one or other of four cortical centers the oblique muscles steady the plane of rotation (a meridional plane) so that it shall bear a fixed relationship to the median and horizontal planes of the head. In doing this the obliques keep the vertical axis of the eye parallel, at all times, with the median plane of the head and compel the transverse axis to lie always in the horizontal plane of the head. This action of the obliques is in the interest of correct orientation.

One, or at most two, of the four cortical verting centers, acting on their respective recti muscles, cause the visual axis to move from one point of view to another in the rotation plane made steady by an oblique, under the influence of one of four cortical centers.

In binocular rotations the cortical centers can make the ocular muscles work in harmony only when the muscles constituting any one of the several pairs are equal in tonicity. Unequal tonicity is provided against by the existence of fusion centers which are basal and under the control of the fusion faculty of the mind. Without these centers it would be impossible for some eyes to have binocular single vision. Unequal tonicity of muscles necessitates continuous activity on the part of one or more fusion centers in order to prevent diplopia.

When there is equal tonicity of muscles binocular rotations in the four cardinal directions are effected without excitation of the basal or fusion centers. When there is orthophoria every oblique binocular rotation excites two fusion centers, but only during the continuance of such rotation. To illustrate: Rotation of the two eyes obliquely up and to the right is the result of voluntary discharge of neuricity from the first, the fourth and the eighth conjugate centers which call into action, respectively, the two superior recti, the right externus and the left internus, and the right superior oblique and left inferior oblique. The right superior oblique, in preventing a loss of parallelism between the vertical axis of the eye and the median plane of the head, helps the externus, but hinders the superior rectus; the left inferior oblique, in preventing a loss of parallelism between the vertical axis of its eye and the median plane of the head, helps the superior rectus, but hinders the internus. Harmony in this rotation is made possible only by excitation of the right first and left third basal centers.

In binocular rotations each eye must obey the law of monocular rotations as if the other eye had no existence; that is, one, or at most two, of its recti muscles must move the visual axis from the first to the second point of view in a meridional plane made so steady by the action of an oblique muscle that the vertical axis shall not lose parallelism with the median plane of the head—all of this in the interest of correct orientation. But there is another law that must be obeyed by the two eyes in the interest of binocular single vision. This law is enforced whether the eyes are still or in motion, and may be expressed in these words: The two visual axes must lie in a plane common to the point of view and the two centers of rotation, and they must intersect at the point of view. It is evident that when the eyes are in rotation, up or down or obliquely, this plane is also rotating and that the axis around which it rotates is the line connecting the centers of rotation of the two eyes. In binocular rotations there is an individual rotation plane (a meridional plane) for each eye, along which the visual axis of that eye alone must move from the first to the second point of view, and there is that other plane in which must lie the two visual axes, the two centers of rotation and the two horizontal retinal meridians.

When the head is erect and the two eyes are in their primary positions, this plane, in which the visual axes must lie, becomes the plane of the horopter or monoscopter; and in this position, the eyes being ideal, it coincides with the extended fixed horizontal plane of the head.

When the point of view is directly to the right or left, this plane remains coincident with the fixed horizontal plane of the head and is motionless, while the visual axes are made to move in it to the second point of view.

When the second point of view is directly above or below, this plane is rotated on its only axis, the line connecting the centers of the two eyes, the visual axes remaining stationary in it, provided the first and second points of view are equally distant from the two eyes. The extent of elevation or depression of the second point of view is measured by the angle formed by the intersection of the fixed plane of the head and the rotated horopteric plane, in the axis on which the plane has been rotated. This is true whether the object be directly up or down or at any oblique angle.

In every binocular oblique rotation, above or below the extended fixed horizontal plane of the head, the plane of the horopter must be rotated directly up or down on its only axis until it reaches the second point of view. This is done by the elevator or depressor muscles, as the case may be, but at the same time the lateral recti muscles are making the visual axes move in this plane toward the objective point, reaching this point at the same time that the horopteric plane is brought to it. Each visual axis, while moving in the horopteric plane, has moved along its own rotation-plane (meridional plane extended). That no torsion has occurred is evidenced by the fact that, at the completion of the rotation, the second point of view, the centers of the two eyes and the two horizontal retinal meridians all lie in the rotated horopteric plane. The final result of any oblique binocular rotation is the same as if the visual axes had remained still in the horopteric plane while it was being so rotated as to reach the second point of view; then this plane having become still, the visual axes had rotated to that point.

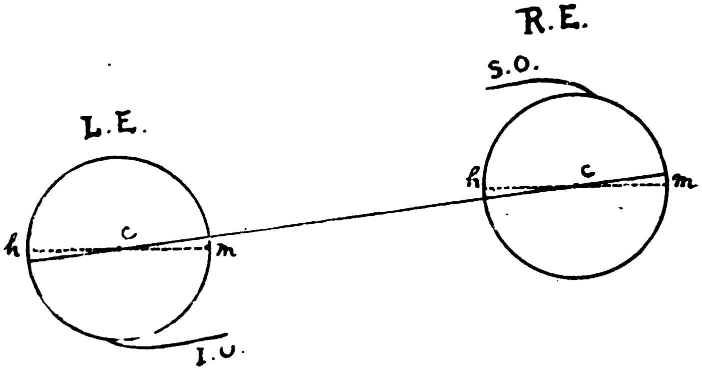

Figure 3.

The setting of ideal eyes in ideal orbits is such that the horopteric plane, when at rest in the primary position, coincides with the extended fixed horizontal plane of the head. All orbits are not ideal as to height, one often being lower than the other by a fraction of an inch. It is not possible for the horopteric plane of such eyes to be properly related to the extended fixed horizontal plane of the head. The horopteric plane must include the visual axes, the centers of rotation and the horizontal retinal meridians, but the fixed horizontal plane can not do so if one eye is lower than the other. Figure 3 teaches an evident truth more plainly than simple words could set it forth. The right eye is represented as higher than the left. The line *c c* connecting the two eyes is the only axis around which the horopteric plane can rotate, and lies in that plane. But this plane can be the horopteric plane only on the condition that it must include also the two horizontal retinal meridians and the two visual axes. A glance at Figure 3 shows how the horizontal retinal meridians may be brought into this plane by the action of the eighth conjugate center on the right superior oblique and left inferior oblique. This torsioning makes binocular vision possible, but it makes correct orientation with the two eyes impossible. The figure shows that the inclined plane *c c* can not coincide with the horizontal plane of the head.

It also teaches that, so long as the two eyes are open, the right superior oblique (S O) and the left inferior oblique (I O) must be in a continuous state of contraction, their center, the eighth, being just as continuously active. Rest from this abnormal work can come to either eye only when the other is covered. The left eye covered, as in refraction, allows the eighth center to rest; therefore, the relaxed right superior oblique will let the horizontal retinal meridian leave the plane *c c*. and assume the position *h m*. Likewise, the right eye covered, the eighth center ceases its activity and the relaxed left inferior oblique allows the horizontal meridian to leave the plane *c c* and assume position *h m*. Astigmatic corrections for such eyes will be faulty unless the axes of the cylinders are shifted in harmony with the necessary binocular torsioning. Eyes that are not level are eyes that can never be made strong, although the proper correction of focal errors may help them. Of such eyes it may be said: "One eye is better than two," however free from focal error and muscle imbalance.

Eyes are never torted except in the interest of binocular single vision, and even then it is at the expense of correct orientation. There are but two conditions that cause torsioning: First, when one eye is higher than the other, there must be a torsioning of both eyes in the same direction, as shown in Figure 3; second, in non-parallel oblique astigmatism, there must be torsioning of the two eyes, but in opposite directions. The first kind of torsioning makes an horopteric plane possible; in the second kind of torsioning there is binocular single vision, but there can be no horopteric plane. The correction of astigmatic eyes that are normally set relieves the torsioning and makes the true horopteric plane possible.

All that has been said in this paper pertains to eyes whose muscles have normal tonicity; but it has been shown that there are abnormal conditions of the eyes in which the normal muscles do abnormal work.

Heterophoric eyes can not have binocular single vision and correct orientation unless the weaker muscle of an unbalanced pair shall receive supplemental power from a reserve brain center—the fusion center for that muscle. To relieve the fusion centers of abnormal activity, and so to relate the two eyes that there may be volitional obedience to the laws governing binocular rotations, the ideal thing to do is to give equal tonicity to the opposing muscles of every pair.

In ocular rotation the visual axis, which is the chief line of direction, being a diameter of the eye, takes the position of other diameters in succession until, finally, it reaches the second point of view. The diameter of the eye that pointed to the second point of view, before the rotation began, must have connected that point and its retinal image, hence must have been the visual line, or line of direction, for that retinal point. All lines of direction, or visual lines, cross the visual axis at the center of retinal curvature, and are radii of retinal curvature prolonged.

Error in location of the posterior pole of the eye not only led to error in teaching as to ocular rotations, but it also led to error in teaching as to the law of direction. Lines of direction are not the axial rays of light, but they are radii of retinal curvature prolonged.

137 Eighth Avenue North.

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CHICAGO:
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# OPHTHALMIC PRACTICE OF THE PRESENT TIME.*

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NEW YORK.

An extremely interesting paper by Dr. George M. Gould[1] on "A Study of Failures in Ophthalmic Practice" has called my attention to the subject of the work of the ophthalmologist of the present, and we may well ask the questions: What is it? What shall it be? Dr. Gould's candid acknowledgment of his failures and the reasons therefor will be readily accepted by most ophthalmologists, who will agree with the premises so well set forth in his paper. But I do not think, however, that the final word has been said as to the causes of our failures, nor do I believe that the present method of examination can not be improved. If we do have failures, such conditions must always exist, more or less, with all medical men, be they specialists or general practitioners. No one is infallible, even the most expert may be misled or fail by reason of conditions which the physician can not control. This subject can not be considered from any one standpoint; the work of all the investigators now working along these special lines in our profession must be included.

We may object to the statement: "By failures to cure I mean the failure to relieve those symptoms due to eyestrain," as we well know, and as Dr. Gould has shown, that we must not consider all "the ills that flesh is heir to" as due to eyestrain. I do consider, however, that in the present state of our knowledge of eyestrain, and the present advanced methods of examination of ocular conditions, our failures will compare very favorably with all other work in the medical profession. If so, then we may justly ask: What is or should be the essential practice of ophthalmology at the present time?

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

[1] Med. Rec., Sept. 30, 1905.

Before we take up the study of the advancement of ophthalmology during the past two decades, let us study some of the reasons for our failures as set forth in Dr. Gould's paper. I note, first, the "want of a good refraction school." In attempting to answer this I must start out with the assertion that I must differ very positively with the statement that "ophthalmology is most inaccurate and unscientific," because I believe fully in Helmholtz's statement: "Ophthalmology is by far the most accurate and scientific of all the specialities of medicine," and, furthermore, because we do agree in our examinations of the refraction and motility of the eye if these are properly and scientifically made. We can never agree on this subject if we do not study carefully the investigations of others who are equally as scientific as ourselves, but instead set up a little pedestal of our own and, standing on it, make the assertion that our work is alone correct, while that of others is all wrong. The investigations of Stevens, Risley, Savage and others surely deserve some consideration even if we can not accept all their teachings. Some of us will be proficient with one method of examination, others will succeed in some other way, but the refraction of the human eye must be a fixed condition, which by proper methods of examination must show the same results to all observers who are sufficiently expert in the use of the objective tests that should be found in every well-equipped oculist's office.

If this be true, we must have good refraction schools in this country, and I would venture the assertion that the refraction schools of this country are more fully advanced and more complete in their teachings than in any other country in the world. The reader of this article may ask: Where is this teaching that is so perfect? The answer is, In no one place nor is it given by any one teacher, but all combined furnish the result. We might say that Dr. Gould's teaching was all that could be desired, but yet I fear that if his methods only —as I understand them—were practiced we should have many failures. What, then, shall the student of ophthalmology do, and where shall he go? I would answer that in this way: Let him listen to the teachings of all the eminent men in this country who are constantly placing their views on ophthalmology before their students and the medical profession; not in a narrow way, by following the teachings of any one man, but by the true and honest way, of carefully studying the methods of all and then combining them in the way that seems best to himself.

Now let us consider what seems to me is Dr. Gould's teaching. "The day of the worship of the scissors or of the ophthalmometer is long in the past." If this implies anything, it is that we must put aside the use of these two instruments as useless and obsolete. Certainly such an assertion would seem an obsession to many well-advanced oculists, and I venture to say that no complete examination of the eye should be made without the use of the ophthalmometer, notably so in the prognosis of myopia. I shall speak of the scissors later, but the doctor can not deny that some cases have failed with glasses and have been relieved with the aid of the scissors.

"Incorrect diagnosis of ametropia" is said to be another reason for our failures to relieve eyestrain. This can not be denied, but is it not a personal fault? Is it not one that must exist in the physician himself and for which he must take the consequences? This almost goes without saying, yet it is not the fault of our teachings; if the examiner of refraction will not devote the necessary time to following out a scientific examination of the refractive condition he must fail in many cases, and if he does give the time to his patients he should be sufficiently expert to notice and to correct every small error either astigmatic or muscular.

Is it an error to recognize and to correct the condition known as heterophoria? Dr. Gould evidently admits that this condition may be present and speaks of certain conditions of heterophoria as esophoria, etc. He states that "esophoria of high degree is not usually curable and is rare." Just here we may find one of the causes of failure, for the proper operation for esophoria does and will cure many cases of this condition after the most careful examination and correct use of the glasses has failed to give any relief. I have seen these cases and have reported a number of them in which a proper operation has resulted in obtaining complete relief of symptoms that have existed for years, and this relief has been permanent, as my records will show. Hence, we have no right to accuse the physician who carefully operates for heterophoria of doing so from a "financial point of view"; the same accusation has been made regarding the operation for the removal of the appendix during the quiescent period, though that assertion has not altered the opinion of some of our best surgeons. Now we must not consider every physician who operates for heterophoria as a tenotomist—I decidedly object to the term, as I think that it is extremely unjustifiable even though it is one that seems to be freely used at the present time. Tenotomy has had its day, since the first operation was performed for the relief of exophoria associated with myopia. To-day this procedure is giving way to the more advanced theory that heterophoria is due to a primary essential weakness of one or more of the rotators of the eyes in relation to its antagonist, and the operation that will strengthen these weak muscles is gradually taking the place of the tenotomy of the stronger muscle. If, then, esophoria may exist, is it not a sufficient corollary that exophoria and hyperphoria may also exist and cause an imbalance and eyestrain that can not be relieved by glasses, even when we have eliminated the "patient's personal equation" and have given the glasses or prisms after a most careful and scientific examination?

As I understand the teachings of those who object to the operative correction of muscular insufficiency, we must examine the eyes under atropin, order glasses, if they do not relieve, repeat the same process and so on. It seems to me like "piling Pelion on Ossa" to reach the heavens, and how many failures do we have by trying to follow that method.

We may reasonably ask: Is heterophoria refractional in origin and innervational in nature? To my mind and from my experience I must answer that question in the negative. What evidence do we have that it is refractional? Some patients have been relieved of their reflex symptoms by the use of glasses. Only this and nothing more, and yet how many patients do not find the expected relief after the most careful correction of their refraction under the use of a mydriatic. There must be a reason somewhere for these failures. Perhaps all this may be infantile in argument, but, as the assertion in an affirmative sense is made over and over again, then the proper correction of that fault should bring about certain relief. Why does it fail in some cases? Because in the patients who fail to find relief there are other causes that are at fault besides the refraction, and chief of these is the imbalance of the ocular muscles. Perhaps this condition *per se* may not be great enough to cause all these many "ills that flesh is heir to," but associate this imbalance with a refractional error, and then we have the true cause of many reflex symptoms and the true reason why some patients who have had their imbalance corrected still have to wear the correction for their refractional condition. I do not think any one has yet claimed that the correction of an imbalance by an operation will at the same time correct an existing refractive error. *A priori* we might as well ask why does Dr. Gould advise his patients to wear prisms with their glasses if the imbalance is only refractive, or why shall we advise prism exercise? These are interesting questions that I trust may be answered at some future time. As to heterophoria being "innervational in nature" I am utterly unable to answer that question, as I have yet failed to find any reasonable explanation of that phenomenon in any writings of those who persistently advance the theory. To me it seems to be only an assertion completely wanting in proof. I shall be more than pleased when I can feel that "exophoria or subnormal adduction" is always curable by prism exercise and proper glasses. I have failed to be so successful with my cases if the imbalance is of any considerable degree. In those patients seemingly helped I fully agree with Winters that muscular tissue built up in this way is not nor can it be permanent. A child's muscular tissue may be developed by constant exercise, but unless that development is supplemented by a perfect metabolism from suitable food the tissues so built up will soon return to their former flaccid condition. It is so with the muscular balance of the eyes. We may improve the power of adduction by the constant exercise of the interni by the use of prisms—but this can not go on forever—and when we stop the exercise then we find the old imbalance returning with exophoria present. Esophoria—or subnormal abduction, if I may use that term—will not yield to the same exercise, and why? There is no answer to that question, nor will the procedure of prism exercise influence a vertical imbalance, yet the remedy for one should be the remedy for all.

Now if we earnestly seek for the true cause of these cases of imbalance, either with or without a refractive error, we must find it in the muscular structure of the eyes. Not in the refraction, a contributing cause, nor in the innervation, as the nerve impulse or the brain centers simply cause the muscles to act according to their functions and to the extent of their muscular development. (I do not think the prize fighter has any more innervation than myself, but I do know that he has more muscular power.) If, then, it is the muscle that is at fault, it must be in an essential weakness of an adductor or an abductor, in all cases of a lateral imbalance.

If these premises are correct, we may find some reason for the many diatribes against the tenotomists or the so-called muscle cutters, as it is a poor substitute for an operation that would strengthen a weak muscle at the expense of a strong one, but that does not prove that "operation cures nothing." If tenotomy is not indicated and exercise will not give a permanent cure, we must have some remedy for these cases, "our failures," and I think that is fully indicated from the very nature of the primary cause. In other words, if the essential cause of all cases of heterophoria is weakness of a muscular function, then the indications for the correction of that imbalance must be an operation that will enable that muscle to act normally. To this end we must turn to surgical means and an operation that will produce this effect can be found in the principle that if we shorten a muscle in its long axis then with the same degree of innervation we must have a greater action of motion on the peripheral part to which the muscle is attached. This stands without question, and reason should indicate to us that if we shorten the externus we must enable that muscle to increase the rotation of the eyeball outward and in this way correct the esophoria. Is this always successful? I can not say that it is always so, unless we could eliminate the personal equation, but I do state, without any reasonable contradiction, that we can restore the muscular balance by such an operation in a vast number of cases, so far as the objective and subjective tests will show. That we must have failures goes almost without saying, but I feel that the percentage of our failures with this operation, when it is fully indicated, will not be greater than the failures to relieve all cases of eye-strain by glasses when the refraction alone is at fault. For the purpose of study in reference to the statistics of refraction and motility, I have taken the last one hundred cases from my books at the date of this writing. These patients were all personally examined as to the refraction and the muscular balance. In three-fourths, or 76, I found no special evidence of any muscular imbalance; among the remaining 24 there are three cases of squint which may be omitted. The remaining 21 patients all presented some evidence of heterophoria of more or less degree, as shown by the Maddox rod test, the prisms and the tropometer. Nearly all had some refractive error that was carefully corrected and glasses ordered. It is fair to assume that, as they did not return, the relief from the symptoms afforded by the glasses had been satisfactory. This reduces the number of cases of heterophoria that need attention to only 2 or 3 per cent. These patients, after the glasses had been fairly tried without relief of their symptoms, were operated on, according to the imbalance indicated by the examination, by the shortening of the muscle with the catgut suture. The final result proved the necessity for the operation.

A new element has been introduced under the subject of eye-strain that should require some attention at the present time; this is called subnormal accommodation. It was mentioned in Dr. Gould's paper, to which I have previously referred, but, unfortunately, though beautifully alluded to, yet we find no explanation of the necessary tests by which an ordinary observer or even a scientific one can make a suitable diagnosis of this condition. To say that it is an "elusive mischief" may express the matter fully, and the rough rule that plus lenses over the distance ones will sharpen the images of ordinary print when held at eighteen inches is hardly a scientific explanation, and one that is simply and wholly subjective. Plus lenses will always sharpen the image of printed matter in the young as well as in the old, but Nature will not admit of such a correction in the young when the ciliary muscle is active and the lens elastic. Theoretically, we should all use plus lenses for the near, so that the divergent rays may enter the dioptric system parallel and so place the focusing muscle at rest. But just as "Nature abhors a vacuum," so will she resent any artificial interference with her natural function of seeing. To see at the near point the ciliary muscle must contract—you may call it habit if you wish—even with the convex glasses before the eyes. Now if our patients can read the finest type—Jaeger No. 1—either without glasses or with the full correction of the static refractive condition at six inches or less, showing full reserve power for the usual reading distance, then I doubt very much if we can have any subnormal accommodation. Furthermore, if patients may accept the plus lenses the continued relaxation of the ciliary muscle will not be tolerated for any considerable time in young people. I always test my patients for the near point, and if I find it sufficiently near I do not think they will need or use convex glasses. It is true that exceptions will prove the rule, and that we do have exceptions I am willing to admit, but I think that the young persons who will use the convex lenses for any continuous work will not have a near point of six inches; they will have a large amount of uncorrected hypermetropia or some general physical condition that needs the services of the family physician more than that of the oculist. This leads us to the point which all oculists should realize: that we, as physicians, must work together; in other words, that the presence of subnormal accommodation is not really the indication for glasses, but shows, rather, that the general system is at fault and that under the care of the family physician, that best of all specialists, the patient will recover without the use of glasses.

Relief from the strain of the accommodation by outdoor exercise for the young, instead of passing the time reading books and papers, attention to hygiene and suitable foods to build up the bodily strength will soon restore a natural function that does not need nor should it ever have artificial aids to seeing. It is a difficult subject to decide impartially; we do not like to send our patients to others. We must consider that the practice of medicine is not a very lucrative one and financial reasons must intrude themselves—as one physician said to me when attempting an operation he should have referred to an oculist, "I wanted the money"—but if we had that true *esprit du corps* between the physician and the specialist, so that the physician could feel "my own shall come back to me," then he would more gladly seek the aid and counsel of one who may be more conversant with that special branch of medicine which the case demands. The same rule holds good on the part of the specialist. He also is a physician, but after he has completed his examination along his special lines and finding that the patient no longer needs his special services, should he not refer the case to the family physician? This is a golden rule that in the end would be productive of much benefit in a financial sense to physicians and to patients. I know that the specialist must treat certain of his patients in whom there are certain pathologic conditions that need his watchful eye and that these patients can not be referred back to the family physician if he considered their best interests. Diseases that involve the iris and the cornea should always be under the exclusive care of a specialist, but many others will do just as well under the care of the family physician after the diagnosis of the ocular condition has been made.

The teachings of ophthalmology of the present time present many changes from that of two decades ago. In my early work on refraction we were wholly dependent on the subjective tests of the visual power. We did not know if the patient's selection of the glass was the correct one, and if we were uncertain we were told to use the "crucial test," or the use of atropin for two or three days, when, the accommodation being paralyzed, the patient must accept the correct glass. It is true we had the ophthalmoscope in those days, by which we could decide the gross errors, as hypermetropia and myopia, but low degrees of astigmatism were not easily recognized. Such was the armamentarium of the oculist in those days, and when I read a paper before the New York State Medical Society at that time on "Our Refraction Cases" the vast majority of them were classed as simple hypermetropia, while imbalance of the ocular muscles was not thought of except in fixed squint and paralysis.

To-day, how different are the teachings of ophthalmology! Now the crucial test is not so often necessary, and in my own teachings the objective methods of investigation of the refractive media takes the first place. I am not a prophet, certainly not in my own country, yet I venture to say and I hope I am correct that the day will come when the physician is so advanced in his refraction work that the diagnosis may be made and the correct glasses given without consulting the patient.

Perhaps that day is far distant, but during the past decade the advances in objective methods have been very great. Javal's ophthalmometer is an exceedingly useful instrument in the diagnosis of astigmatism and has demonstrated that it is in the anterior surface of the cornea in the vast majority of cases. The same instrument enables us to measure the radius of the cornea, by which we have an indication of the refraction. and in myopia the differential diagnosis between benign and pernicious conditions; in other words, between axial and refractive myopia. Furthermore, the retinoscope has come to us in the past two decades, and with this instrument we have an excellent method for the diagnosis of the refractive condition of the entire dioptric apparatus and one that is particularly useful as an objective method with children and illiterate persons. These are scientific instruments conceived, and their uses elaborated in a scientific manner, and with proper study and constant use will fulfill all that can be required of them. Their use can not be mastered in a day nor in a month, but I know that when we have fully appreciated the principles on which the examination depends the application of these tests, even without the use of a mydriatic, will reveal the static refraction of the human eye in almost every case. I do not state that these instruments are infallible, but I do think that if associated with these instruments we employ a careful and systematic method of the subjective test the crucial test will be seldom used or found necessary.

A scientific examination should not end with the correct estimation of the refraction. We can not say that the fault, or, I might say, the cause, of all the phenomena of eye-strain exists in the refraction. Errors must be corrected carefully and scientifically, but after that has been done we still meet with failures in some of our cases, not many, perhaps 4 or 5 per cent. With proper glasses these patients are better for a time and then the old symptoms return. Why? If they have been carefully examined, then changing the glasses will do no good and the fair and honest oculist must extend his examination to the motility of the eyes.

We see by the action of the refractive media on the rays of light from the pages of our books, etc., but to make that vision perfect we must have binocular vision; in other words, the eyes must work together so that the image of the object may fall on corresponding regions of the retinæ. This is one of the most beautiful functions of Nature that can and must be adjusted by the action of the straight muscles of the eyes, assisted by the oblique, to keep the vertical meridians parallel. Now if there is an imbalance of any of the ocular muscles, not sufficient to cause squint, but that does require a constant effort of innervation of one or more muscles to keep up this constant fixation of the visual lines when the vision is in the distance or in the near, it seems to me that this constant effort of fixation, this work that calls forth the constant innervation of a muscle or muscles about the eyes, must cause some symptoms of eye-strain. Nature has certainly a fixed standard of vision; that is acknowledged by all oculists; and I can see no reason why we should not have a fixed standard of rotation that will equalize the necessary innervation of the ocular muscles. This is denied by some observers, even to the extent of saying that no case of eye-strain can be due to a want of balance between the opposing muscles, and others that a comparison between the action of one muscle and that of the opposing one has no foundation in fact and is useless as a test. But observers and investigators have opposite views, and why? Because the careful and repeated application of strictly scientific tests in their cases proved the correctness of their views.

If, then, we admit the existence of an imbalance of the ocular muscles—and no oculist can deny it if he will read what Seguin taught some twelve years ago[2]—it goes without saying that the teachings of ophthalmology must include this subject. When we consider how important these movements of fusion and of fixation are to the individual, how beautifully they are adjusted to the wants and the pleasures of the human race to-day, how essential they are to the preservation of binocular vision, then it becomes imperative that we should understand the normal function of fusion and of fixation. We can not see when the eyes are moving; they must come to a state of rest, so that the images may be formed on corresponding parts of each retina, and if the muscular apparatus that controls this function is at all in imbalance there must be certain symptoms of eye-strain with, perhaps, certain phenomena of reflex conditions. What, then, is the normal function of fusion or duction and of fixation or version? Do not the daily wants of the individual show it? The eyes are at rest when the visual lines are parallel and the look is in infinity, and when the look is directed to the near point the visual lines are convergent. These are the requirements of the visual act in our daily life, and Nature has provided for it, as we find that adduction must always be greater than abduction, as about three to one. The function is voluntary and is controlled by the lower brain centers. This is well shown by the prism test, and I believe that a comparison between these rotations under the stimulation for fusion is essential and necessary.

Furthermore, the function of orientation or the topographical sense—to see around us without moving the eyes—is the function of our field of vision; but to see clearly in any one particular region the eyes must be directed to that point. This is the function of binocular vision and depends on the conjugate movements of the eyes, controlled by the higher brain centers. Here we find the field of version or fixation, with its limits established at the points to which the eyes can be turned from that of the first position, with the head immovably fixed. This, again, is a clearly demonstrated field, in which the rotations of the eyes have certain limitations that can be scientifically measured by an excellent objective instrument, the tropometer of Stevens. It is found in the normal field to be about 55° inward and about 50° outward from the position of rest with the look in infinity and about 33° up and 50° down. If we consider these as normal or standard fields, will not an imbalance show a decided change in these limitations?

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[2] Seguin: New York Med. Jour., Dec. 3, 1892.

Is it not as necessary to teach the method of making these investigations in the study of eye-strain as that of the refraction of the dioptric media? It goes without argument that this must be so. This is my method of teaching ophthalmology, and I venture the assertion that an eye which has normal vision and normal fusion and fixation will not have any symptoms of eye-strain, either reflex or in the eyes themselves. I will not dwell on the correction of these cases of imbalance except so far as to say that the more I study this condition the more I feel convinced that all imbalance is primarily and essentially due to an abnormal anatomic weakness of some one or more of the straight muscles of the orbit. If this contention is correct, then I do not advise any muscle cutting, but I do advise the operation known as shortening, by taking a tuck in the muscles and with the use of the catgut suture. I will conclude with the words of Dr. Gould, whom I have quoted so freely: "But when all has been confessed, discounted and allowed for, the truth remains that in no department of medicine is practice so satisfying, in none is cure so much the rule, as in refraction work." But I would add to that assertion: If to our refraction work we also consider the possibility of an imbalance of the ocular muscles our failures may be less and our satisfaction may be greater.

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# CONJUGATE LATERAL DEVIATION.*

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It seems a well-established fact that all the movements of the eyeball which are innervated from the cerebral cortex are associate or conjugate. It also seems well established that lateral conjugate movements of the eyeball can be effected through stimulation of the center for the sixth nerve, or on the floor of the fourth ventricle. Of the associate or conjugate movements of the eyeballs, the lateral ones are the most extensive; and this is consistent with the fact that the human being can move about on a plane surface to an extent which is limited only by physical obstruction or the deficiency of his motor apparatus.

Dangers which threaten the human being come, as a rule, in the nature of things, from some direction in the plane on which he stands. They rarely come from above, and more rarely still from below. The associated movements of the eyeball downward are much limited, and those upward still more so. All movements of the eyeball that are conjugate are assisted and supplemented by the movement of the head, and it is evident that the movements of the head to the right and left are greater than in other directions. These reflections bear directly on the importance of the conjugate movements in general, and particularly those to the right and left.

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Prevost first pointed out the significance and importance clinically of conjugate deviations of the eyeballs as a symptom of apoplexy; but this is a fugacious symptom and passes in a few hours, because in the first place it is a distant symptom and, in the second, the sound side of the brain probably learns to perform the duty of the stricken side. As will be shown in a case later to be cited, localization from conjugate deviation is uncertain, both on account of its transitory character and because the position of the cortical center for associate movements is not yet established.

Landouzy, Wernicke and Henschen, from clinical and postmortem study, have located the center in the inferior parietal lobe. Munk arrived at the same conclusion from experimental study. Ferrier, on the other hand, observed conjugate deviation from electrical stimulation of the angular gyrus, but, as this experimenter at that time thought the angular gyrus the center of vision, he concluded that the reaction obtained was in the nature of reflex from the visual center to the oculomotor center. Ferrier, together with Horsley and Beevor, have placed the center in the second frontal convolution.

Schaeffer and Munk more recently found that faradization of one visual center caused conjugate movements of the eyes to the opposite side, and Munk showed that this occurred even though the association tracts between the visual and what he regarded as the oculomotor centers were cut. From this he concluded that involuntary fixation of the eyes on the stimulation of light is caused by a reflex to nerve nuclei from the visual center and through the optic radiations. Knies has also put forward some interesting views to show that the cortical center for vision is also the cortical center for voluntary conjugate motions in so far as they are caused by a conscious visual impression, and supports this view by an elaborate scheme. By the same scheme he also shows how auditory and tactile sensations likewise may produce voluntary associate motions. Even in the case of Wernicke, in which a lesion of the inferior parietal lobe caused conjugate deviation, Knies thought that the close proximity of the inferior parietal lobe to the visual cortex was sufficient to have produced the deviation. It appears that this amounts to subsidizing a fact to support a theory.

It appears that conjugate lateral paralysis is the only form of associate paralysis which can be caused by primary nuclear disease. The vertical forms of conjugate paralysis have in the main been associated only with tumors of the corpora quadrigemina. Gowers, Thompson and Steffen have reported such cases. This symptom also is regarded as distant, and does not necessarily imply that a center exists in these bodies like to that in the nucleus of the sixth nerve for conjugate lateral movements; but it seems clear that tumors of the corpora quadrigemina in some indeterminate way act on the nuclei for associated upward and downward movements so that their power of innervation is eliminated or modified. These paralyses of the lateral associated movements of the eyeballs necessitate the existence of fibers passing from the nucleus of the third nerve to the other side, which fibers, of course, are destined only for the internal rectus of that side. It is interesting to know that this conclusion is justified by the findings of Graux, who has demonstrated the existence of these fibers. They are properly called associate fibers, for it is by means of them that the associated movements to the right and left are accomplished.

## AUTHOR'S CASES.

I have observed two cases of lateral deviation. One, I believe, was the result of irritation; the other, of destruction.

**Case 1.—A man, aged 40, was attacked by an acute otitis media.**

***History.*—He suffered great pain and the drum-head burst of itself within twelve hours. The pain in the ear was re-**

lieved, but the head pain not only did not lessen, but became worse and began to radiate over his forehead toward the opposite side. His symptoms increased in severity and his pulse gave indications of meningitis. After twelve hours of intense suffering he became unconscious and comatose, with puffing respiration. His right leg was flexed on his thigh, the thigh on the abdomen, and both were inclined toward the median line. His forearm was flexed on his arm and his hand was in the classical position of *La Main en Griffe*, his thumb pointing toward his palm. At the same time his eyes and head were turned toward the left, the right eye being turned inward further than the left eye outward.

I saw him twenty-four hours after the rupture of his drum; the mastoid was normal, and I was not able to convince myself that it was tender on pressure. There was a large opening in the drum downward aud outward, from which pus slightly tinged with blood flowed freely. I was in a quandary as to the diagnosis. The contraction of the leg, arm, and hand pointed to an irritative lesion of the left cortex, and the deviation of the eyes to the left pointed to an irritative lesion on the right side or a destructive one on the left. Meningitis was diagnosed, but in view of the conditions of the mastoid and the rapidity of the attack I could not bring myself to believe that the middle ear was the cause. This view was strongly fortified by the contractions of the right hand, arm and leg. It was assumed that there was a lesion of the left cortex, indeterminate in character, and that a general meningitis was present. In several hours the deviation to the left had disappeared, and subsequently the eyes deviated to the right. At the same time his head no longer pointed toward the left, but did not point to the right. The possibility of infection from the mastoid was again entertained, but the quandary was not removed. In the meantime the man was moribund, and died about fifty-two hours from the time of his attack.

*Postmortem.*—The postmortem was most interesting. There was a general purulent pialmeningitis, most marked on the right side and over the frontal region, but absolutely general. There was no lesion in the left cortex, none in the right, nor any in the ventricles. There were, however, petechial hemorrhages, very fine in character, on the anterior aspect of each middle lobe. On removing the brain from the calvarium a red spot was seen on the tegmen tympani of the right temporal bone, just short of where the wall rose to form the parietal boundary. A hairpin thrust through this small opening entered the mastoid cells and could be pushed into the antrum. The petrous portion of the temporal bone was removed by a chisel and the cells of the entire antrum, though fresh and clean in appearance, were completely filled with thick yellowish pus. It seemed in the highest degree probable that this hiatus was a congenital one, because the process had not continued long enough to produce destruction of the bone.

This region must have been rapidly invaded by the pus after its entrance into the fossa, and it is my opinion that the primary deviation to the left was due to the irritation of the pus on the right inferior parietal lobe. When the pus passed over to the opposite side the fresh irritation not only relieved the original deviation but caused the eyes to deviate to the opposite side.

This at least is consistent with the view that the inferior parietal lobe is the cortical seat for conjugate lateral movements, and it is obvious that these reflections support the view of Landouzy, Wernicke and Henschen as to the location of the cortical center of the lateral conjugate movements.

Case 2.—This case is quite as interesting, though the drama has not yet been closed by a postmortem. A tall, heavy, strong South German, aged 37, had syphilis five years ago. He apparently recovered from all signs of it under treatment, and about a week before I saw him (Oct. 25, 1905) he suddenly noticed something peculiar about his eyes. On being questioned he stated that he did not see double, but noticed that his forearm, hand and leg seemed numb, and that he could not use his hand well in his work, which was that of a baker. These symptoms passed away rapidly. On being questioned further concerning the double vision, he said that he saw single except occasionally when he was returning from work at 8 a. m. He was accustomed to go to his work at 3 a. m.

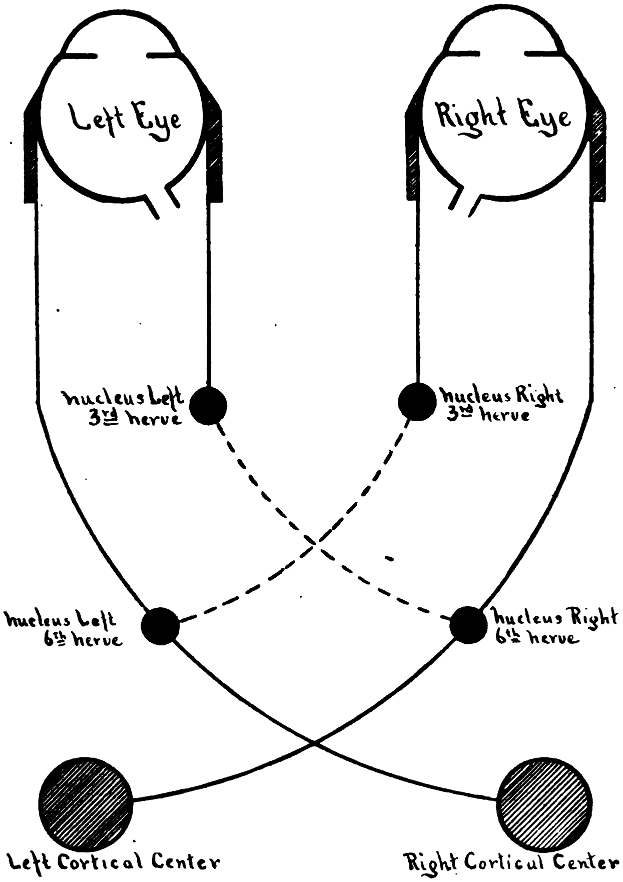
*Examination.*—I examined patient on Oct. 25, 1905. His eyes stared, but there was no lagging of the lids and downward movement. Both eyes were turned distinctly to the left; at times this was more marked than at others. The right eye looked in further than the left looked out. The power of convergence was present and seemed to be normal, the convergence being equal in the two eyes for a given point. He could not be made to see double in any part of the field, even with the red glass test. The pupillary reflexes in the fundi were normal. The fields were normal, and the vision in each eye was practically normal, with the correction of a slight refractive error. In walking he habitually carried his chin toward the right shoulder. There was no difference in sensation to the prick of a pin in his hands, arms and legs, but his grip appeared to be a trifle weak. There was no Romberg and apparently no difficulty in orientation, although his walk suggested slight ataxia. The patella reflex on the left seems a trifle increased; on the right side, normal.

*Treatment.*—The patient was put on increasing doses of potassium iodid, but could take no more than 50 gr. three times a day. He has continued the iodid of potassium in the stated dosage to this date, Dec. 13, 1905. The eyes appear to be straighter in general than before, but when the left eye arrives at the median line the right eye still appears to incline inward. Patient says he feels much better and does not have to carry his head so much to the right in walking, but he is not yet able to carry his eyes beyond the median line to the right. He finds that the fingers of the left hand are still somewhat stiff and clumsy in his work. There is no difference in sensation between the two hands.

## REMARKS.

It is evident that this case is one of conjugate lateral paralysis, the lateral movements to the right being paralyzed. Practically all the signs and symptoms of a classical case of conjugate lateral paralysis are to be seen here, and what is marked and distinct is that the paralysis of the external rectus of the right eye is more pronounced than the paralysis of the internal rectus of the left eye. This is entirely consistent with the generally recognized view that the center of the sixth nerve is the commanding one in lateral associated movements. That this is not a true paralysis of the internal rectus muscle is clear from the fact that the convergence is practically normal. This is eminently the fact in the case under discussion; therefore, none of the fibers for true convergence are influenced, but only those for associated movements to the right.

It is interesting and instructive to consider for a few moments the mechanism of spasmodic and paralytic deviation from the standpoint of the different locations of the lesion. By reference to Figure 1 it will be seen that in either case paralytic or irritative deviations may be due to a lesion either in the cortex or in the nucleus. If, for example, the lesion be destructive and lie in the left cortical center, it is obvious that there will be a



deviation of the eyes to the left. If, in like manner, the lesion be a destructive one and in the right cortex, there will be a deviation of the eyes to the right, so that the eyes will look to the side of the lesion when it is destructive and cortical. If, however, the cortical lesion be an irritative one and lie in the left cortical center, the eyes will deviate to the right. If an irritative lesion lie at the right cortical center, the eyes will deviate toward the left. Therefore, in destructive cortical lesions the eyes look toward the lesion; in irritative cortical lesions the eyes look away from the lesion. When the lesion lies in the nucleus, it is clear that these conditions are reversed. Let us suppose a destructive lesion at the nucleus of the left sixth nerve. The external rectus of the left eye would thus be paralyzed, and the internal rectus of the right. The eyes will, therefore, look to the right; in other words, away from the lesion. If, in like manner, the destructive lesion be at the nucleus of the right sixth nerve, the external rectus of the right eye and the internal rectus of the left will be paralyzed and the eyes will look to the left; in other words, away from the lesion. An irritative lesion of the left sixth nucleus will cause a movement obviously to the left; the eyes in this case will look toward the lesion. An irritative lesion of the nucleus of the right sixth nerve will cause the eyes to look to the right, or toward the lesion.

It now becomes of interest to settle the probable position of the lesion in the case we have before us. The deviation here is to the left, and it is a paralytic deviation. It can not, therefore, be an irritative right cortical lesion, because there is paralysis; but it might conceivably be a destructive lesion of the left cortex; for, as we have seen, that lesion will produce deviation to the left.

It will be remembered that there was a transient left hemianesthesia and hemiplegia that would necessitate the existence of the lesion on the right; and, since the deviation in this case is to the left, it is obviously not a destructive lesion of the right cortex, for that would produce a deviation to the right. We are, therefore, forced to the inevitable conclusion that the lesion is a destructive one and lies at the nucleus of the right sixth nerve. The sixth nerve, or abducens, originated mainly from a mass of gray substance on the floor of the fourth ventricle near its widest part, at a point practically corresponding to the posterior border of the pons varolii. From this point the fibers pass downward and forward through the tuber annulare to the posterior edge of the pons varolii, where they may be seen on the base of the brain. Hence, it runs along the wall of the cavernous sinus and through the sphenoidal fissure to the eyeball. If the lesion in this case be not absolutely at the point of origin of the sixth nerve, at least it is somewhere in the immediate vicinity and is above the decussation of the pyramids. The hemianesthesia and hemiplegia, fugacious as they were, distinctly implied that the motor and sensory fibers for the left side were involved. Whether or not the hemianesthesia and hemiplegia were restricted to the left arm and leg and did not involve the rest of the left side is not obvious from the history; but that the lesion was syphilitic there can be no doubt in the face of the history given. It is a fact that there was no hemiplegia present, nor can I clearly see how it might have occurred, if the lesion be truly on the floor of the fourth ventricle. A cortical lesion associated with hemianesthesia and hemiplegia might have been accompanied by hemianopsia.

The following are the salient features of this case:

1. Conjugate lateral paralysis, with deviation to the left.
2. Fugacious hemianesthesia and hemiplegia.
3. The location by exclusion of the lesion at the nucleus of the right nerve.
4. The absence of hemianopsia.

5. The obvious predominance of the external rectus as opposed to the internal rectus.

6. The retention of normal convergence.

It has been said that simple abducens paralysis may be caused by a nuclear lesion, but if it be true that a lesion of the sixth nucleus causes conjugate lateral paralysis, then lesion of this same nucleus can not cause simple abducens paralysis, and the so-called nuclear paralysis of the sixth nerve must be due either to a lesion in the efferent fibers from the nucleus to the external rectus (Bennett and Saville) or to a lesion of the communicating fibers (Knies).

I think it unwise in describing the position of the eyes in cortical and nuclear lesions, whether irritative or destructive, to make any reference to the paralyzed side, since the paralysis is obvious. It is better to define the direction of the eyes by reference to the seat of the lesion. I suggest the following arrangement:

Irritative lesions { Cortical: eyes look away from lesion.
Nuclear: eyes look toward lesion.
Destructive lesions { Cortical: eyes look toward lesion.
Nuclear: eyes look away from lesion.

34 West Thirty-sixth Street.

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ONE HUNDRED AND THREE DEARBORN AVENUE,
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# INCURABLE EYESTRAIN.*

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I can find in text-books no systematization, no explicit statements, not even any distinct recognition of a series of clinical facts illustrated somewhat frequently in office practice, and still more frequently in hospital and dispensary work.

In thinking over my cases I have been surprised that so many have had eyestrain from causes beyond eradication or neutralization. The conditions being as they were, it was impossible to stop symptoms that were evidently due to what we call eyestrain. The causes simply could not be reached. We have looked at these conditions from every other standpoint except that of eyestrain, while it was precisely the eyestrain that mostly concerned the patient. Let us take this point of view:

Eyestrain[1] may be defined as the local reflex, or general results of ocular effort caused by congenital or acquired defects or weaknesses of the optical or sensation-making mechanisms of the eyes, by over-use of normal eyes, by injurious occupation, etc., or by diseases of other organs, which interfere with ocular function. Eyestrain is incurable, of course, when these pathogenic causes are ineradicable.

The recognition, in an individual case, of the precise reasons why eyestrain is incurable, or of the conditions impossible to remove, is highly necessary, in order:

1. That we may make the patient understand the unfortunate limits and circumstances of his life; that we

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

[1] "Eyestrain" is an incorrect and misnaming word, but it has become so common and accepted that it is now impossible to supply its place by a better and more accurate term.

may advise him against certain occupations, prescribe for him the best hygienic safeguards, whereby symptoms may be avoided, dangers lessened, etc. In such cases it is especially necessary that he understand the precise nature of the fatalism under which his life must be lived.

2. That other physicians, in ignorance of the nature of his trouble, may not err by treatment of the patient, or by operations, which can not affect the single source of the mischief. It is bad enough that thousands of patients should be gastrologized, laryngologized, gynecologized, etc., for easily curable eyestrain, but it is far worse when the eyestrain is incurable. Hunted by their mysterious disease, patients blindly and vainly pursue relief by running from one physician to another, drift into invalidism, or into a despair which often ends in the suicide either of self-delusion (quackery, Eddyism, etc.,) or of genuine self-murder.

The causes of eyestrain that we are unable to abrogate or neutralize may be classified as follows:

1. Congenital anomalies.
2. High degree of ametropia.
3. The sequelæ of inflammatory disease, traumatism, etc.
4. Amblyopia, or other injury of ametropia.
5. Chronic heterophoria or heterotropia.
6. Interruptions or contraindications of the normal coördinations of dextrocularity and dextromanuality.
7. Cerebral or neural disease.
8. Systemic disease, or diseases of interrelated special organs.
9. Injurious occupations, unhygienic use of the eyes, etc.

1. *Incurable Eyestrain Due to Congenital Defects, Etc.*—The most important and most frequent of these congenital anomalies is albinism, that strange failure to secrete the customary pigment of the dermal structures of the body, of the retina, iris, etc. Many years ago I published the results of a good deal of study of "The Pernicious Influence of Albinism on the Eye." It is a pity that the lessons of that study have been so little heeded by ophthalmologists, for the pathologic significance of albinism is almost wholly confined to the eye, and there is no class of possible patients more in need of our help and none so neglected. Although we can not do away with all of their afflictions, we may greatly mitigate them. The crushing pressure of the lids to shut out the light produces a high degree of astigmatism, at axis 90 degrees in hyperopes, and this, with much patience in diagnosis, may be relieved. In

this relief there is perhaps a doubling of the visual acuteness. But at best we can bring the albino to only about 20/50 of normal vision. Possibly also by this lessening of the amblyopia we lessen a little the nystagmus. I gather that this nystagmus of the albino is the result of a continuous and never-to-be renounced search for a portion of the retina not so exhausted by the flooding light as is the macula region, whereon the image may fall, and which will give the brain a more delimited or defined image as a stimulus. The significance of ocular albinism pertains preponderatingly to the iris. If that could be pigmented the albino's case would not be so hopeless or grievous. In one case I tried an experiment of fitting a 1/4 in. ametropia-correcting lens in the center of a deep tinted London-smoked toric lens. The sudden cessation of the nystagmus which resulted brought the man down in a swoon and I could get no repetition of the experiment.

Colobomas and many other anatomic defects of the eyes may in many ways interfere with the formation of optical images. These anomalies of the fundus, I think, are not so likely to produce eyestrain as are those of the iris. For a number of years I have treated a girl with a coloboma of the iris directly below the pupil in the left eye, about ¼ in. wide at the pupillary margin and narrowing at the corneal border. While she was a child and not studying much there was not a severe eyestrain, but as she advanced in years and scholarship there was no correction of her ametropia that gave more than the palliation of her severe headaches, brought on by study. If one might dare, if there were no danger, and if the operation were surgically successful, thorough tattooing of the cornea over this rent would undoubtedly give her relief. The continuance of her studies, amount of near-work permitted, and the ordering of her life depend on the severity of her eyestrain symptoms.

There are many other kinds of congenital anomalies which might produce eyestrain, such as microphthalmos, cataracts, peripherally located pupil, malformations and malpositions of the lenses, persistent hyaloid artery, pupilary membrane, enophthalmos, etc. I have no sufficiently well-observed cases to report illustrative of the principle involved. I have no doubt I have negligently overlooked a number. In congenital cataract or in case of lenticular pigment spots occupying much of the pupillary area it may be best to permanently atropinize the eye.

2. *High Degrees of Ametropia.*—These are in one sense, perhaps, examples of congenital anomaly, especially that of hyperopia of six or more diopters. Illustrative cases have occurred in all of our practices. What we are likely to forget is that they must almost always necessarily handicap the patient, even if, as may rarely happen, the normal visual acuteness may be retained. This will arise either because amblyopia has been chronic or has been firmly established before proper glasses have been secured, or because no glasses can give perfect correction of such cases. I remember one patient whose errors were:

R. + S. 8.00 + C. 2.75 ax. 68°;
L. + S. 7.75 + C. 2.75 ax. 105°.

Neither eye had been disused and the vision in each was 20/60, later 20/50. It would have been better if this defect had been anisometropic. A second case shows the same amblyopia:

R. + S. 8.00 + C. 1.00 ax. 20° = 20/60
L. + S. 7.50 + C. 1.00 ax. 150° = 20/60

After six years' struggle reduced to 20/20.

In another case showing:

R. + S. 6.00 + C. 2.50 ax. 180°
L. + S. 5.75 + C. 1.75 ax. 150°

the right had been excluded and only 20/60 vision retained, while the other eye was brought to 20/20. In such cases anisometropia is a poor, but preferable blessing. If we could place our lenses (as has been dreamed of) inside the lids, and give them the same motion as the eyeball, the problem would be solved, at least in great part. It is possible, but not probable, that this may be done. In approximation to this ideal our lenses should be toric, set as close to the cornea as possible, after close cropping of the lashes.

In high astigmatism the first effect of full correction may be rejected as irritating until the ocular mechanism has become habited to it, and until the necessity becomes unconscious of turning the head instead of the eyes, in looking at objects not in the center of the field of vision. When there is high anisometropia, there may be some degree of persisting eyestrain, although I have found it will generally and eventually yield to obstinate persistence, unless the amblyopia has by neglect become incurable. I have one patient, coming to me in middle life, who is now successfully wearing over a six-diopter correction of monocular astigmatism, with re-establishment of almost lost visual acuteness, and with relief of long-existing ocular reflexes. The sole ametropia of extreme proportions that cannot possibly produce eyestrain is simple myopia in a one-eyed person. One of my patients, a great literary genius, lived for about thirty-five years, and during this time did an enormous amount of literary labor every day, with a single eye, having about twenty-five diopters of uncomplicated myopia, and he did this without the use of correcting lens. His pen point was necessarily placed about three inches from the cornea. He never showed a sign of eyestrain as we define the term. His optical defect and necessity had a subtle and profound influence on his intellect and character, and on the literary qualities of his published works—but "that is another matter."

In hyperopic defects, and especially in those of high degree, there is, of course, and almost always, a greater or less admixture of astigmatism; and this demands correction with perfect nicety, in order to prevent malfunction. Toric, close-fitting lenses, usually bifocals, frequent changes, skill of the optician, and all the rest, are of the utmost importance. Moreover, in high binocular ametropias there is likely to be incoördination of the external ocular muscles, and also, not to be overlooked, frequent irregularities of accommodation. Partial paralysis of accommodation, or undevelopment from disuse, is likely to exist in such cases and differing in degree in the two eyes.

As to high defects the following are noteworthy:

R. + S. 0.50 — C. 4.50 ax. 15° = 20/50
L. + S. 0.50 — C. 5.50 ax. 180° = 20/50

The anomalous axis of the right did not throw this eye out of function, because the man was a right-handed man, and the left clung to life because of its normal 180° axis.

I have a little fellow twenty-seven months old who is wearing B. E. + Sph. 10.00, apparently with almost equal acuteness of each eye. We shall probably find some astigmatism when he is a year or two older. His strabismic eye is now straight, and the glasses are so grateful to his nervous system that the baby yells, *Wo sind meine Gläzele,* if they are left off a minute.

A man of 36 could barely count the fingers with his right eye. and no lens seemed to improve. I stuck to the problem instead of calling it "amblyopia," and I found that — Sph. 6.50 + Cyl. 9.00 ax 10° saved the man's eye and gave him 20/50 vision. This 15.5 D. in a nontraumatic case, at least in one meridian, is the highest I have ever met. There was 6.00 D. in the left, with 20/40 vision.

3. *Inflammations and Trumatisms.*—These may have such organic and irremediable defects in one, or even in both, eyes, that the visual act becomes thereby pathogenic. The most common of these conditions is, perhaps, the nebulous or leucomatous cornea following keratitis. In the young (and the younger the better the success) we may often lessen the opalescence by Pagenstecher's ointment and massage, and other methods of treatment. Unfortunately, Dr. Alleman's proposal of electric stimulation by the contact electrode has not, as was hoped, been adopted or demonstrated of much value.

A profound impression was left on my mind by the history of one patient, a man sent to me by a general physician, with the ready-made diagnosis of "migrain." The man had never had sick headache, so his disease was not "migrain"; the general physician could not cure this patient's headaches, so he sent him to me. I at once notified the physician, 1, that the man never had had "migrain"; 2, that the man's headaches were caused by eyestrain; 3, that in all probability I could not cure the man of his eyestrain headaches. This was because he had a nebulous cornea of the left eye, also a very high mixed astigmatism, giving about 20/50 vision. I ordered glasses, and impressed on the patient the necessity of returning soon and frequently. Pursued by the relentless mystery of his pain, the man fled to the neurologist, who drugged and massaged him without relief; the neurologist then turned him over to the rhinologist, who took out all the turbinates of one side of the nose, saying those of the other side must be taken out, and eventually the frontal sinus opened up "by two holes." The man fled. In this man's case, I shall exclude the left eye from vision, if I can get him out of the hands of the operating rhinologists and the neurologists.

These untransparent corneas almost always cause eyestrain sometimes of a most grievous severity. I fear we greatly neglect to take this fact into consideration, and dismiss without explanations to the patient, and sometimes without correction of the ametropia. In rare cases, possibly the ametropic correction may not, especially at first, give relief; it may more rarely even increase the eyestrain, by stimulating the waning and fading effort and possibility of helpful and useful fusion which must be finally renounced. The problem then becomes most complex and perplexing, and demands the highest judgment and skill to meet it. But purposely to exclude an eye from vision under such circumstances is a hazardous procedure, and needs long pondering. I have not, I think, been compelled to do so more than once, while final success has generally followed ingenuity and persistence to save. I have had one most instructive case which astonishingly proved the wisdom of ***nil desperandum.*** It was that of a man nearly frozen to death. The keratitis had produced such a dense leukoma, and apparently ruined eyeball that several good oculists advised enucleation, fearing sympathetic inflammation of the other imperfect, but still functional eye. Enucleation was not allowed, and later the better fellow was utterly ruined, and now with the eye pronounced doomed, the man has 20/40 vision and lives a useful life.

Incurable eyestrain is a necessary result of conical cornea.

The adherent irises following neglected or badly treated iritis are often sad evidences of professional ignorance and lack of skill. If occlusion of the pupil is added, not much is left except despair, and "making the best of it." I judge that an artificial pupil generally only adds to the misery. In such cases hope of cure being renounced, the choice may lie between *laissez-faire,* or hastening the exclusion of the eye, or of the cortical center, from participation in vision. But, first, there should be a desperate attempt at ametropic correction, for, with it, nature may keep up the struggle with less pain, and with less eyestrain; even a small degree of vision preserved in one eye, avoids the danger of blows, injuries, etc., upon the blind side of the head. Rents at the corneal border of the iris, causing double pupil, etc., inevitably produce eyestrain until nature excludes the eye from visual influence. Should tattooing sometimes be tried before it is too late? I have one patient with traumatic rupture of the iris, the pupilary edge being attached to the cornea. There is also an undiagnosable irregular astigmatism. The eye is too good to exclude from vision, and the patient's symptoms are not those of traction on the adherent iris; they are due to eyestrain, but I can not relieve them. For ten years I treated a patient, one of whose eyes had been ruined by a faulty operation. There were three artificial pupils. I had to exclude the eye from vision until the sensation was dulled and denied.

Cicatrices in or near the cornea from wounds, injuries, and operations, and producing irregular astigmatism, not seldom as we all know, cause eyestrain.

Bungling operations on the lids, entropion, ectropion, etc., have also an influence in making the visual act harder to carry out. One of my patients had a fistulous opening on the cheek through which the tears trickled all her life. It was made by a great surgeon twenty-five years ago in an attempt to open the tear-duct in dacryocystitis. She had had enough of operations, and would not dream of more. "Weeping eyes" suffused with tears are somewhat common, with eyestrain as an inevitable result.

There is in my mind little doubt that the chief cause of senile cataract is uncorrected or miscorrected ametropia. In eyes previously long and properly glassed it does not occur. We all know how incipient cataract often increases eyestrain and necessitates frequent changes in refraction. "The headache of incipient cataract" has become a familiar term. If the cataract is monocular and is advancing, I think it generally advisable to exclude the eye somewhat early. Usually the earliest stages do not affect the center of the pupilary area. When the clear space chosen for vision is at one side of the pupil, eyestrain inevitably follows from the effort to get the macula in line with it.

I have had cases in which vitreous opacities seemed to cause or increase eyestrain. They oftener cause the patient great worry and quacks make much money out of them. Muscæ volitantes do not cause eyestrain, if they are really physiologic, as properly speaking they generally are. One has constantly to calm the fears of patients in reference to them.

Ametropic choroidoretinitis[2] is very common, indeed, almost always exists in long uncorrected ametropia. It is a perfect example of the "vicious circle" of disease, for it is the result of eyestrain, the local effect, and at once it becomes the cause of further eyestrain, both local and general.

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[2] See Archives of Ophthalmology, 1890.

Other forms of choroiditis, and of retinochoroiditis, do not usually produce eyestrain unless the macula region is implicated, and unless it has ended in floating vitreous opacities. If one macula is destroyed or badly injured, eyestrain is inevitable until the eye is dulled to functionlessness. If both eyes are affected, the eyestrain must be persistent. I had a patient with both maculas so equally and irremediably hurt that new maculas had formed above the old ones. I sent him to live on a Western ranch, where he is happy.

Tenotomomania usually results in incurable eyestrain. After the muscle-tailor has done his work there is not much we can do, except to apply the proper glasses and wait for Nature's possible undoing of the injury through years of suffering. I remember one patient who had no 'phorias whatever after twenty-eight tenotomies by one graduate tenotomist. The machinery of head and body was largely devoted to getting his head in position to see every degree of change of imagine. His ocular muscles had been surgically paralyzed.

4. *Amblyopia, or other Injury of Ametropia.*—I have elsewhere published a study of "Amblyopiatrics," or the cure of amblyopia, when it is curable. The majority of patients have some degree of ametropic choroidoretinitis or amblyopia from eyestrain, and the majority of these are entirely curable. In extreme cases it is not curable.

The eyestrain of incurable amblyopia usually depends on the amount of near work done. A young lady patient of mine with 20/40 vision from old uncorrected astigmatism was free from symptoms in her home, but when she went to college there was great suffering. In childhood, in a very few years, strabismus will often render the eye visually useless, even though made cosmetically useful by surgical operation. I had one patient with what I called squint hemianopsia, the temporal half, vertically, of the retina being wholly blind. One may never be sure how much the amblyopia from disuse which follows the eyestrain exclusion of an eye from visual function is due to retinal or cortical causes. And one can also never be sure that the worst cases may not be improved by long and patient amblyopiatric methods.

Some years ago a European physician found a couple of children supposably blind in a blind asylum, who still had some perception of light. He educated this remnant of function, first, in distinctions of light; second, of color; and third, of form, until the children were taught to read and were rescued from a life of blindness. A blind patient over 50 years old has been suddenly brought to perfect physical and sensational vision by operation, but it took some years to perfect intellectual vision. The lesson in all cases of amblyopia is that we should trust nature and help her by ingenuity and patience to improve amblyopia, and to renounce only when the impossible is demonstrated. I have had but one case in which I had to exclude the eye from vision, because the little improvement possible was a little improvement, and was not further improvable. The influence of dextrocularity in conjunction, of course, with dextromanuality will usually result in the retention of better visual acuity in the right, even with greater ametropia in the right. Nature will always aid more to save the right-eye vision than the left in the dextral.

Accommodationlessness, that is, undeveloped accommodation, may be a result of chronic exclusion of one eye from function for near work, caused, of course, by ametropia. I have had at least three patients whose ametropia was such that one eye was used for near only, and the other only for distance. The latter eye had no accommodational power. If caught early enough in life the defect may be remedied by bifocal lenses. If the patient has passed adolescence, such a device will scarcely prove successful, and the established habit must be permitted to continue; but some eyestrain will also persist. The least intermixture of astigmatism will demand glasses, e. g.,

R. — S. 2.50 — C. 0.50 ax. 50°
L. — Cyl. 0.25 ax. 140°

and fusion will come at once.

Subnormal accommodation[3] is far more frequent than is supposed, and its existence has been a prolific source of many of our past failures to relieve eyestrain. We must be on our watch for it in every patient. None of my successes have been more brilliant or satisfying both to patient and oculist than the half hundred in the past few years, by attention to this most important condition. I now have a child of nine, and another of twelve, wearing bifocal lenses with admirable results. I have found a few cases in which the subnormality differs in the two eyes.

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[3] See Am. Med., Jan. 21, 1905.

Only the best conscience and the most expert intellect may rightly decide when to persist in stimulating or coaxing an amblyopic eye into use, and when to exclude it.

5. *Heterophoria.*—This cause of eyestrain appears to me refractional in origin and innervational in mechanism, but when it is too high, or of too long standing, it may produce eyestrain, either because too great injury has been done, or because reinstatement of orthophoria is impossible. Preventable all such conditions are, but I have not seen tenotomy of service. In the young if orthophoria is possible, by operation, it is possible by means of glasses, orthoptic exercises, etc. And without proper glasses no operation is useful, because it was the ametropia that produced the heterophoria.

Strabismus has the same law with the exception that its genesis is in childhood, is quickly established, and the irreparable injury sooner completed. With strabismus fixed eyestrain ceases, because nature has despaired of help, and has renounced effort. Heterophoria is the cry of the dying eye for help; heterotropia is its epitaph. The strabismic death may sometimes be only resignation and coma, and resuscitation still be possible. Undoubtedly we frequently give up the struggle too quickly. But it is murder to delay intervention, as I was taught, until the child should be 7 years old. Such opthalmology should be put on trial for murder in the second degree. I have cured strabismus by glasses alone in patients over 30 years of age.

In those patients reaching us over 40 to 50 years of age, with high heterophoria, would it be wise to advise operation? I hardly think so. One of the best illustrative cases I have was that of a woman who had 33° of esophoria. I should have lost my patient if I had demanded operation. I incorporated with her ametropic correction 13° prisms in each eye for distance, and 7° for near, and she has never for years had enough discomfort to make her think of operation. By a marvel of the optician's art her lenses are not very heavy or unsightly.

6. *Interruptions or Contradictions of the Normal Co-ordination of Dextrocularity and Dextromanuality.*—When traumatism, inflammation or other cause conflicts with or extinguishes the established co-ordination of dextrocularity and dextromanuality so that the left eye (in the dextral) must take up the proper dextral function of the right, eyestrain, at least for a time, almost inevitably results. There is an awkwardness, indecision, slowness, etc., of action, thought or vision, probably of all three, which may be more or less lasting. I have had a number of such cases, but the particulars are too numerous to find room here.

7. *Cerebral or Nerve Disease Occasionally Causes Eyestrain.*—Paralysis of accommodation, not from peripheral causes, but from cerebral ones, may exist, overlooked, in one or both eyes. Some eyestrain will still exist even with bifocal lenses. Failure of detection may be caused by the cycloplegia and may be present without a noticeable mydriasis. I have had a number of such cases.

Permanent myosis may cause incurable eyestrain because of evident optical reasons. I had one such case in which a famous neurologist could find no evidence of neurologic disease to account for it, and we both failed to bring about any alleviation of the symptoms patently eyestrain in nature. I had a theory that the myosis in this man's case was due to a tiny corneal opacity in the center of the pupil. My neurologic friend scorned such a philosophy.

Slight nystagmus, with small and almost undetectable excursions, flutterings, or tremblings, may, as will be readily understood, produce eyestrain. In one patient, a woman of 50, there was the most rare symptom of rotary nystagmus, which no glasses could cure. And I have had one case of monocular nystagmus that to some degree caused incurable eyestrain, although the young man had only 3/200 vision in the affected eye. Possibly the diplopia of paralytic strabismus may not be properly classed as eyestrain, and yet in one sense it is so. I have had to put two such eyes out of function by a steamed or ground glass, so slightly obscure as not to attract attention, and which at the same time would not allow vision.

There is no evidence that color blindness may co-operate in producing eyestrain, but it is possible that it may do so. Certainly in the beginning stages of optic atrophy there would probably be such an effect. I have reported a remarkable instance of hereditary optic atrophy occurring only in males, transmitted only by females, taking place from 28 to 34 years of age, and running through six generations. While the disease was in its early stages and ingravescent, one of these patients had decided eyestrain symptoms, not to be relieved by any means, of course.

I have had several patients in whom tremor of the head was a source of eyestrain.

I recently discovered one of the most unsuspected ways in which a disease of the central nervous system may produce eyestrain. I have no doubt that my little report is so far unique. My glasses had failed, in part, to relieve in a woman of 40 the symptoms of decided eyestrain in reading, not in writing. There was no subnormality of accommodation or other discoverable cause of the perplexing fact, until I noticed that her hands had a rapid and constant tremor. I placed her newspaper or magazine against a solid body, or in a book-rest, and the shivering was stopped, which caused ocular tiring.

*8. Disease of the General System.*—This condition, affecting directly or indirectly the nutrition or functions of the eye, may sometimes have some effect in causing eyestrain. This factor has been so ludicrously overemphasized in the past that it needs no more than mention here. Many "conservatives" who care nothing for scientific refraction problems have practically thrown the baby away with the bath, and have really sought to resolve all eyestrain into systemic disease. Although 99/100 of their contention is ludicrously untrue, there is, nevertheless, a possible 1/100 of truth in it. Although diseases of the nose and accessory organs may rarely affect the eyes, the rhinologist, and surely the operative rhinologist will have little work to do when the enormous influence of eyestrain on the nose is recognized. Much the same may be said of the gynecologist, the celiotomist, the gastrologist, and even the general physician.

*9. Eyestrain Due to Unhygienic Occupation, Use, or Abuse of the Eyes.*—In our offices we have constant evidence of these causes. Most of these cases are obviable or remediable, and their consideration goes over into the chapter on hygiene of the eye. This is indeed a chapter which, speaking resolutely, still remains unwritten, and which, when written, will not become popular reading for a century. During this waiting-time millions of eyes will be ruined, and vast reserves of health foolishly wasted. But in a minority of cases we find ourselves unable to prevent eyestrain, so plainly present. I have often run across the prejudice of employers, school trustees, and especially of railroad officials, against spectacles, even though the employé suffer and the lives of train-loads of people are jeopardized. The trainmen or switchmen say that the superintendent will probably "lay them off" as too old, whether presbyopic or not, if they show themselves in glasses. We should manage to convince the officials of the double folly of their ways.

Half of the clerks, stenographers, bookkeepers, etc., are compelled to carry on their work with poor lights, wrongly placed lights, etc., and when the lighting of their desks is good, the employé himself omits many other wise measures preventing eyestrain. Our school desks and commercial desks are universally flat, but when ophthalmology becomes ophthalmologic, and when civilization becomes civilized, they will be made sharply pitched. The unphysiologic, unophthalmologic, outrageously stupid writing posture of the occidental world begets a big deal of eyestrain, and most of the lateral spinal curvature which curses 27 per cent. of our school children. That we look sharply downward on our writing, etc., instead of off, from, and slightly downward, that we pathogenically angle our paper, are other sources of eyestrain, which we shall long and vainly struggle to change.

There are many other occupations which variously contribute to the conditions of eyestrain.

Lastly comes the fact on which is based the whole theory of the origin of eyestrain, namely, the impossibility of the long and continuous innervation and contraction of any single muscle or set of muscles in the human body. Rhythm is the law of life, and surely of muscular contractility. The modern human eye is often put to tasks which it is incapable of carrying out. Normalized accommodation (that is, accommodation without any ametropic morbidizing), is in fact always subnormal, when it is required to be executed with scarcely a break or change for hours, almost a whole day, and for all days of the year and life. Nature never made the eye for such work, and has not outfitted it with an adequate mechanism.

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# SOME PERSONAL EXPERIENCES IN THE USE OF ELECTRICITY IN OPHTHALMIC PRACTICE.*

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This report will be limited by request to the use of the galvanic and the form of alternating current known as the sinusoidal. That the subject of electricity in ophthalmic practice has received scant attention appears from a statement by the secretary of this section, Dr. Bulson: "For several years the subject has received no consideration. In 1898 Dr. Starkey read a paper on 'The Use of Galvanism in Pterygium,' and Dr. LeMond on 'The Value of Faradism in Choroiditis.' Since then nothing has been presented except some papers on the galvanic cautery and the magnet."

It is probably safe to say that there is no remedy which causes so varied physiologic manifestations and therapeutic results as electricity. By proper selection of modality, current strength, tension, polarity, length and frequency of application, etc., stimulation or sedation of the nervous and vasomotor systems, muscular contraction, decomposition and destruction of tissue, changes in nutrition and so forth may be produced. This "proper selection" requires a fair working knowledge of the physics and electrotherapeutics of the agent. Ranged on the side of "working knowledge" will be found those (conspicuously neurologists) who are securing recoveries by electric agencies, and have an enlightened faith in still greater future conquests, while, on the side of those who lack this knowledge, are conspicuously ophthalmologists who frankly admit this lack, neglect almost completely the use of electricity, and look askance at electrotherapeutics as the real means of recovery from disease which may have previously resisted the classically authoritative drug habit, and prefer to attribute the result to suggestion, coincidence or the bogey man.

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Of all the modalities, galvanism furnishes the greatest variety of useful application to the eye as well as the rest of the organism, while, with the possible exception of radiotherapy, it requires the most skill for its safe and successful administration.

For the most part I have used electricity in chronic cases which are very intractable or usually considered not amenable to medication. In order that results may be properly referred to the current, the diagnosis, when possible, has been confirmed by confrères, other treatment avoided, and in several instances patients had been treated without success by the usual approved methods for long periods.

The cases embraced in this paper are taken from my records, without selection, except to include those treated for a sufficient time to warant a fair conclusion as to the possibilities of the remedy. For the sake of completeness brief mention will be made of cases previously reported.

A word in regard to the nature and selection of the current used, and the technic of its application:

Previous to 1890 the galvanic battery of zinc-carbon elements, excited by a solution of potassium bichromate, was used, and since then the Edison street current, controlled and measured by the rheostat and meter of the ordinary wall plate.

The alternating or sinusoidal current has been taken from a No. 2 Victor transformer, using from 30 to 35 measured volts, and a quantity estimated at 5 milliamperes. As the heat meter is not applicable to so small a quantity, it was thus estimated: With a force of 30 volts taken from the direct current, and the electrodes placed on the lids and the nape of the neck, the meter registered 5 m. a., hence, with the same voltage from the alternating current and the same resistance.

### PHYSICAL CHARACTERISTICS OF THE GALVANIC AND SINUSOIDAL CURRENTS.

The maximum voltage of the No. 2 Victor transformer is 70, and the milliamperage probably 1,000. The maximum speed is 2,800 revolutions a minute, and the alternations 5,600. While the current alternates, the sinusoidal wave is unbroken or continuous. Figure 1 represents the wave.

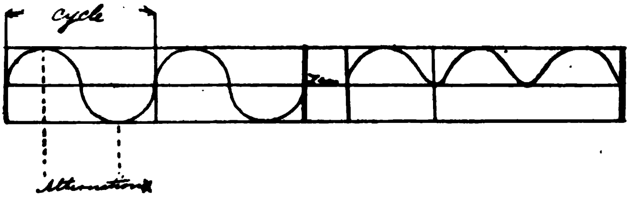

Fig. 1.—Curve of undulating galvanic current.

In the absence of any tracing of the wave from the dynamo, I am not convinced that it is perfectly sinusoidal. Still, it is quite possible that a similar therapeutic effect may result from a wave that lacks its perfect symmetry. The galvanic current is used when its electrolytic property is desired to separate chemically the elements of a pathologic body, and when its polarity may be utilized as a sedative or a stimulant to the muscular, vascular and nervous tissue. For example, in consecutive optic atrophy, galvanism is especially indicated, on account of the existing exudates, while in primary atrophy I much prefer the alternating current, as it appears to be more stimulating to the nerve, the greater reaction of which is evident by the more intense light flash produced.

This can be shown by comparing a thirty-volt current from the dynamo with a thirty-volt galvanic current. The former is not unpleasant and causes a brilliant mosaic of dark and light, while the latter causes no phosphenes unless the current is interrupted and the burning is so intense that it can not be endured for more than a half minute.

The almost universal opinion that the alternating current has no electrolytic effect seems at least doubtful. A current of thirty volts causes as much decomposition of water as one of 5 m.a. from the galvanic, and potassium iodid in solution is readily decomposed, although with an equal amount of discoloration at each pole.

Since the exposure of the eye to the static, high-frequency, $x$-ray or faradic current causes no phosphenes, such currents probably have very secondary if any value in optic atrophy. The technic is as follows except when otherwise stated: Galvanism is generally applied with a large positive pad, 3x4 inches (to prevent smarting) to the nape of the neck, and the negative pads to the closed lids for ten minutes daily, with a current of from 5 to 10 a.m., generally the latter. The electrodes of the sinusoidal are similarly placed and from 30 to 35 volts, as can be tolerated, used for ten minutes daily.

Case 1.—Double optic atrophy. Vision improved in each eye from ability to count fingers at twelve inches to 6/18.

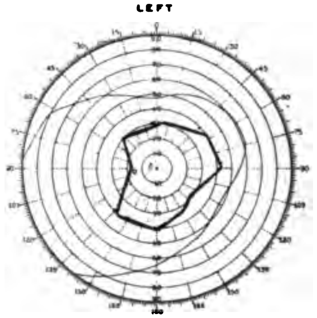

Fig. 2.—Case 19, Feb. 3, 1903.

*Patient.*—Mr. B., aged 61, was struck on the forehead in August, 1896. When first seen he presented advanced optic atrophy. He had been treated medically at the Illinois Eye and Ear Infirmary for three months and at a South Side hospital, and had been discharged with failing vision and an unfavorable prognosis.

*Treatment.*—He was treated four months for five minutes daily with galvanism with the cathode to the closed lids and anode to the nape of the neck, with the above result.

Case 2.—Optic atrophy (left). Vision increased from reading 16 Jaeger to 1 Jaeger.

*Patient.*—Miss C. S., aged 11, suffered from a sunstroke in June, 1882, and for four months after could only distinguish light with the left eye, then sight improved for five months and remained the same for two months up to May 24, 1883, when letters of 16 Jaeger could be read slowly on the temporal side.

*Treatment.*—Strychnia gr. 1/32, t. i. d., was administered for a month, when V = 14 J. Galvanism was then applied, as in the previous case, daily for a month, when vision increased to J. 1 at six inches with central fixation.

Case 3. — Double optic atrophy. R. V. increased from 10/200 to 16/200, L. V. from 6/200 to 10/200.

*Patient.*—Mr. J. C., aged 53. His sight had been failing for eight months. His history was negative and he had leaden white discs; the vessels were normal.

*Treatment.*—Galvanism was applied daily to the eyes; hypodermic strychnia daily was increased to 1/16. Treatment was continued one week with above result.

For the past ten years I have abandoned the use of strychnia, as I have never been convinced that it has any curative effect in optic atrophy.

Case 4.—Double optic atrophy. R. or L. V. = 6/36. No improvement in vision.

*Patient.*—Dec. 28, 1891, J. P. W., aged 37, noticed a cloudiness before the eyes after a Turkish bath four months previously. He has smoked from fifteen to twenty cigars daily till a year ago, but none during the past three months. He had syphilis sixteen years ago and mixed treatment for two years. There is a question of tabes. O. D. V. = 6/36, O. S. V. = 6/36.

*Treatment.*—In spite of large doses of potassium iodid and hypodermics of strychnia to gr. ⅛, galvanism for a month and a month's treatment at Hot Springs, the vision remained the same, 6/36.

Case 5.—Decolored left disc. Vision increased from 20/200 to 20/40.

*Patient.*—Mrs. E. D. C., aged 47. The left eye has been blurred for a week. L. E. V. c —13.00 = 20/200; temporal side of disc was decolored.

*Treatment.*—After nine galvanic applications to the left eye, V. c — 13.00 = 20/40.

Case 6.—Vitreous opacities and choroiditis. V. R. E. improved from light perception to counting fingers at 6″. V. L. E. from fingers at 5′ to fingers at 10′.

*Patient.*—Mr. J. L., aged 26, had failing sight for seven years. His history was negative.

*Treatment.*—Galvanism was applied to the eyes daily for nine days with the above result. After two and a half months more at the West Side Hospital by mixed treatment V. R. E. = fingers at 1′; L. E. = fingers at 10′.

The rapid improvement under galvanism is in marked contrast to the progress under mixed treatment.

Case 7.—Dust opacities in the vitreous. R. V. increased from 18/30 to 18/20. L. V. from 18/70 to 18/40.

*Patient.*—Jan. 25, 1866, H. S. L., aged 58, had noticed a fog before his eyes for four weeks. He had no history of syphilis or of other disease. The discs were decolored.

*Treatment.*—Galvanism was applied daily for four weeks.

CASE 8.—L. E. Floating bodies in the vitreous; Disseminated atrophic choroiditis. R. V. c glass = 6/15 improved to 6/9. L. V. = 6/15. Not improved.

*Patient.*—Mrs. P., aged 49. Her sight has always been poor in the left eye; she cannot distinguish people across the street. Right fundus appears normal.

*Treatment.*—She was treated at long intervals with galvanism. She can now distinguish people across the street and is confident that vision has much improved.

CASE 9.—R. E., no reflex from fundus. L. E., dust opacities. Vascularization of the vitreous. Retinitis hemorrhagica. V., R. E. = light perception, not improved. V., L. E., improved from fingers at 7″ to 6/22.

*Patient.*—April 19, 1897, Mrs. M., aged 61. Blindness set in suddenly in the right eye eighteen months previously, and vision had been failing in the left for two months.

*Treatment.*—After treatment by galvanism daily and hydrargyrum submuriate gr. 1/15 hourly for three and one-half weeks. V., L. E. = 6/22. A month later vision suddenly failed, probably due to a fresh retinal hemorrhage.

CASE 10.—Floating opacities in the vitreous. R. V. improved from 6/12 to 6/6; left, 6/50 to 6/15.

*Patient.*—March 15, 1897. Mrs. H., aged 64. The right eye failed very much of late, the left had been failing during the past four years.

*Treatment.*—Galvanism was applied daily for one month with above improvement in vision. Patient returned in a month with V. R. E., 6/7; L., 6/15. There are still abundant dust opacities in each vitreous.

CASE 11.—Recovery from nictitation.

*Patient.*—March 13, 1886. B. H., aged 8, has had nictitation since an attack of measles one year previously. He has had a good deal of pain in the eyes.

*Treatment.*—Galvanism was applied to the lids daily for eight days. No pain or nictitation.

CASE 12.—Recovery from asthenopia.

*Patient.*—Oct. 17, 1897, Miss B., aged 21, teacher. Her eyes have been weak and painful since childhood and she has photopsies. She is unable to read more than half an hour with glasses prescribed by an oculist, who referred her to me for treatment. She is troubled with insomnia and dyspepsia.

*Treatment.*—After three weeks of galvanism, daily, to the eyes, this patient can read as long as she wishes, has no photopsies, and eats and sleeps well.

CASE 13.—Recovery from asthenopia, headache, and neurasthenia.

*Patient.*—Nov. 3, 1893. Miss G., aged 15, school girl, has had frontal headache for months and the eyes and head ache after reading an hour in the day or a few minutes in the evening. Comp. H. As. Exoa. 2°, 20′; 8° in accommodation. Ad. 9°, Ab. 4°, converg. 10 m. a., Stim. Ad. 30°. No insufficiency of obliques. Bilateral contraction of visual fields. Glasses, months of prism exercises (Gould), prisms of rest, medication and long vacations afforded no relief to the head or eyes, though her health improved.

*Treatment.*—Treatment by galvanism was begun Sept. 21, 1896, and continued daily. Dec. 12, 1896. She has rarely had a headache during the electric treatment and can read any length of time in the day or evening with perfect comfort for the past month.

CASE 14.—Retinal thrombosis. Recovery.

*Patient.*—April 1, 1898. W. A. W., aged 57. The vision of his right eye failed suddenly two months ago, and it is now reduced to counting fingers at 14″. The fundus has a retinal grayish opaque area in the infero-temporal quadrant.

*Treatment.*—Galvanism was applied, negative to the lids, positive to the nape of neck, 10 m. a. daily. Vision improved daily and on the twelfth day = 6/15, and seeing the second hand numerals on watch 1 m. m. in diameter.

The above cases are fully reported in the *Annals of Ophthalmology,* July, 1898.

CASE 15.—Central retinitis, unimproved.

*Patient.*—Jan. 20, 1902. Miss O. L., aged 20, noticed failure of sight at the age of 9, one year after an attack of measles. She has been unable to read book type since September. Under hyocin each eye, with — 0.50 — 1.00 90° = 20/120. There were fine dots of pigment infiltration in each macula.

*Treatment.*—Treatment with potassium iodid and mercury, and with the interrupted galvanic, and the sinusoidal current failed to increase vision.

CASE 16.—Paresis of r. inferior and internal recti, and of the sphincter pupillæ. Recovery.

*Patient.*—Feb. 11, 1902. W. F. S., aged 35, clerk. Seven weeks previously he lost consciousness for four days, during which time the right arm and leg were paralyzed. He then recovered consciousness and the use of the arm and leg. Three weeks later diplopia was noticed; this was increased by looking to the left and down. R. hypertropia, 5°; exotropia, 15°.

*Treatment.*—Interrupted galvanic current; 5 m. a. was applied, negative pole to lids, positive to neck, for ten minutes daily.

February 20, exota 8°, R. hyperta 3°. April 2, exota 1°, R. hyperta 2°. April 26, orthophoria. Binocular field of fixation normal.

CASE 17.—Amblyopia exanopsia. R. E. V. improved from 6″ to 2′.

*Patient.*—April 12, 1902. J. P. S., aged 37, printer. The right eye has diverged since childhood. V. R. E. is now about the same as it has always been; he can see the tips of the fingers at 6″. Fundus appears normal.

*Treatment.*—The sinusoidal current was applied to the eye ten minutes daily. On Feb. 12, 1903, he could distinguish thumb from fingers at 6′. He is much pleased with the result as he can now see objects approaching from the right side, which enables him to get about the streets more safely.

Case 18.—Bluish-white atrophy of left optic nerve; slight improvement from light perception.

*Patient.*—May 15, 1902. L. F. C., aged 45, has noticed the left eye to be defective in sight for ten years, but it could see to read until last winter, and since then vision has gradually failed. V. L. E. = 20/80; V. R. E. = 20/20. L. E. Numerous large and small floating opacities in the vitreous; visual field nearly absent on the nasal side and contracted on the temporal. Health is good; history is negative. On Nov. 4, 1902, he returned with only light perception in left eye.

*Treatment.*—The sinusoidal current was applied to the eye ten minutes daily. On Dec. 22, 1902, he could distinguish when the hand is open or shut. He discontinued treatment unexpectedly.

Case 19.—Retinitis pigmentosa. R. E., — 1.00, 15° = 20/80; improved to 20/40. L. E., — 125, 165° = 20/80; not improved. (Fig. 2).

*Patient.*—Jan. 29, 1903. Dr. A. B., aged 48, had good sight until an attack of measles in childhood; since then night blindness has prevented him from going out in the evening, and vision has been steadily failing. During the past seventeen years reading or fatigue caused a pain from the frontal to the occipital region, which glasses have considerably relieved. Fundi: Bars and plaques of pigment infiltrated along the peripheral retinal vessels. Family history good. No history of consanguineous marriage.

*Treatment.*—The sinusoidal current was applied to the eyes daily. On March 2, 1903, there was no pain in the eyes since treatment, and vision was as above.

Case 20.—Amblyopia exanopsia. R. E. improved from 20/120 to 20/80.

*Patient.*—Jan. 10, 1903. Maud F., aged 10, has been cross-eyed for some years. Esotropia with red glass test = 20°. Homatropin, R. V. c + 4.50 = 20/120; L. V. c + 4.00 = 20/40.

*Treatment.*—Galvanic current was applied to the eyes tri-weekly. May 12, 1903, tenotomy of right internal rectus was performed. July 25, esotropia 6°. V. R. E. 20/120. She has stereoscopic vision and 10° range with the amblyoscope. The exercises were repeated bi-weekly.

Nov. 7, 1903: V. R. E. = 20/120. Sinusoidal current was applied to the right eye tri-weekly. Jan. 4, 1904: V. R. E. = 20/80.

Case 21.—Sequelæ of specific relapsing iritis. V. R. E. improved from ability to count fingers at 10′ to 20/200. L. E. from light perception to 20/70.

*Patient.*—Feb. 2, 1904. A. N. N., aged 42.

*History.*—He had a chancre two years ago in May, 1902; five months later, the left eye was attacked with iritis, and seven months later the right. Vision had been good previous to these attacks. He was under the care of an oculist for five months, beginning a week after the attack in left eye. Hydrargirum and potassium iodid were prescribed. He has taken iodid of potassium up to the present time. At the end of five months, with the right eye he could see to read a letter, but with the left he could not see a hand.

*Second Attack.*—This occurred August, 1903, in the right eye, and continued two months without treatment. Vision has remained as at present during the past three months. R. E. V. = counting fingers 10′; L. E. has light perception. Under atropin: Pupil of R. E. 3 mm.; pupil of L. E. 2 mm. Fleecy opacities in each vitreous. Retinal vessels and discs invisible. In fixation at 6″ the left eye diverges.

*Treatment.*—Galvanism ten minutes daily, the negative pole to the nape of the neck and the positive to the lids.

March 7, 1904: R. E. V. = 12/200; L. = 20/200.

April 4, 1904: R. E. V. = 15/200; L. = 15/120. The sinusoidal current to the eyes. Galvanism discontinued.

April 19: R. E. V. = 15/120. Discontinued sinusoidal current to the eyes and applied vibratory pneumatic masage with eye cups to eyes daily for five minutes.

May 2: Vision the same. Discontinued massage and applied the high frequency current from coil and Oudin resonator with vacuum electrodes to eyes daily for ten minutes.

May 13: Vision remains the same. I discontinued the high frequency current and applied galvanism. I gave dionin 5 per cent. daily for five days, then omitted it for two days, and repeated.

Oct. 6, 1904: R. E. V. = 20/200; L. E. V. = 20/70.

Case 22.—Double optic atrophy, probably of cerebral origin. V. R. E. improved from light perception to 20/67. V. L. E. from 20/120 to 20/20.

*Patient.*—Oct. 3, 1903. L. W., aged 12, school boy, suffered from very severe headache, vomited about twice a week and was very delicate from the age of five to ten. He has been in good health during the past two years. On returning to school September 9 he noticed that he could not see figures well on the blackboard, and for a week past has had to read with his book very near his eyes.

*Examination.*—Skiascopy: R. E. + 1.00; L. E. — 0.50. Ophthalmoscopy: R. E. very white marginal band with gray center of disc; vessels normal. L. E. opaque white disc; white atrophic choroidal patch to the nasal side of disc and two-thirds its size; vessels normal. (Fig. 3).

*Treatment.*—Sinusoidal current.

October 23: R. E. V. = Light perception; L. = 20/80.

November 20: R. E. counts fingers excentrically at 6″; L. E. V. = 20/80.

Jan. 7, 1904: R. E. V. = 15/200; L. E. V. = 20/30.

February 4: R. E. V. = 20/120; L. E. V. = 20/20.

March 7: R. E. V. = 20/80; L. E. V. 20/20.

April 25: R. E. V. = 20/70; L. E. V. = 20/20. The papillæ appear as white as when first examined. Treatment discontinued.

Feb. 13, 1906: R. E. V. = 20/50; L. E. V. = 20/20.

Case 23.—Xanthelasma electrocuted.

*Patient.*—Jan. 18, 1904. Mrs. A. R. J., aged 37.

*History.*—Four years previously three yellow patches appeared on the lids, one below the right inner canthus, one below and one above the left. They are at present ⅛″ by ¼″ in size.

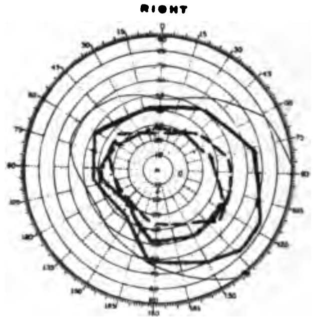

Fig. 3.—Case 22, April 25, 1904. White —; blue — —; red — - — - -

*Treatment.*—Hypodermic cocain. Negative galvanic needle beneath the left upper patch, 3 m. a., gradually increased to five for four minutes, and this repeated with the needle at right angle to first insertion. There was no pain.

January 30: Patch absent; a small crust present. Needle used as above on the remaining patches.

February 20 and April 21: Needle again used.

May 21: Patches absent.

Case 24.—Tobacco and alcohol amblyopia. Double optic atrophy. V. R. E. improved from 6/100 to 9/100. V. L. E. improved from 4/100 to 9/100.

*Patient.*—Oct. 4, 1904. H. B. C., aged 36.

*History.*—His sight began to fail in March, 1904, and he has been unable to read ordinary type since, but he can read large type in the dusk of evening or by artificial light. He has smoked since the age of ten and during the past two years has averaged fifteen pipefuls a day of native tobacco, and washed it down with from three to fifteen whiskies daily. The outer two-thirds of the discs are bluish-white. V. R. E. =6/100; L. E.= 4/100.

*Treatment.*—Toxics discontinued; strychnia gr. 1/24 t. i. d.

October 31: R. E. V.=8/100; L. E. V.=4/100. Discontinued strychnia. Sinusoidal current applied to the eyes.

November 9: R. E. V.=8/100; L. E. V.=4/100.

December 15: R. E. V.=9/100; L. E. V.=9/100. The soreness of the eyes is relieved and he can now read editorials in Frank Leslie, which he could not do previous to treatment.

CASE 25.—Optic atrophy from wood alcohol. V. R. E. ½/100; L. E., 1/100, decreased to ability to counting fingers.

*Patient.*—Feb. 15, 1905. H. B., aged 45, is a fresco painter and plumber.

*History.*—He gives the following history relative to his loss of vision from inhalation of methyl alcohol. He positively denies ever having taken methyl alcohol in any form to his knowledge. During the past five years has not drank more than two or three glasses of distilled liquor, but has used malt liquors, beer, etc., two or three glasses weekly, and not more than five glasses in any one day. He has used wood alcohol in his work for the last ten years, the last five very freely.

On this particular occasion he was using it to remove varnish from the floors of two air-tight rooms. For three hours he worked on his knees, using a handless steel scraper. All this time he was inhaling the fumes arising from the alcohol, which covered the entire floor space. At no previous time had he ever spent longer than one hour in a closed room doing similar work. Then, as now, he experienced the same dizzy feeling, but this is common, no matter which kind of alcoholic fumes are inhaled. After leaving his work in the closed room he set out to walk home, three blocks distant. He at once became nauseated, the dizziness increased, and, shortly after getting home, he fainted. In about five minutes he regained consciousness, and got to bed, but found he could not see. He remained stone blind for one week, then showed some improvement.

December 10: R. V.=1/100; L. V.=1/100.

*Treatment.*—Strychnin sulphate, gr. ⅛, hypodermically, t. i. d. Sinusoidal current daily.

Jan. 5, 1905: R. V.=½/100; L. E. V.=1/100.

January 20: R. V.=1/100; L. V.=1/100. He can see pictures better and the headlines of a newspaper.

February 3: R. V.=1/100; L. V.= 2/100.

May 3: R. V.=½/100; L. V.=2/100. No treatment had been given since February 15. L. E. cannot count fingers. The disc is bluish white. There is double optic atrophy.

CASE 26.—Impaired vision and headache relieved.

*Patient.*—March 24, 1905. S. B., school boy, aged 11, fell and struck his head five days previously and had constant frontal headache since. R. E. V. c. lens = 20/40; L. 20/25. Fundi normal.

*Treatment.*—Galvanism anode 3 m. a. ten minutes daily to eyes.

April 12: R. E. V. = 20/50; L. = 20/25.

April 25: Adenoids curetted. Galvanism repeated.

May 3: R. E. V. = 20/25; L. = 20/20. There has been little pain in the head except during one-half day at school. Treatment discontinued.

September 16: He has had no headache for three months past and now reads comfortably. V., R. or L. = 20/20.

CASE 27.—Intraocular hemorrhage in right eye, with only light perception; unimproved by three months' previous treatment. Recovery, with normal vision.

*History.*—May 22, 1904. Dr. A. S., aged 39, was taken ill on March 4, 1904, losing consciousness, and on recovering it two days later found that he could only distinguish light. His memory, hearing, and sight remained bad for a week, and then he recovered. Ten days later he had pain in the left eye in the evening, and the next morning both eyes became again blind. Nine days after the first attack the three oculists consulted agreed in a diagnosis of hemorrhage in each vitreous. Later he consulted four oculists, three of whom agreed with the above diagnosis, while one considered the case choroiditis, with exudates. Under treatment the left eye recovered normal vision, while the right eye has only had light perception since the second hemorrhage.

Previous treatment consisted of pilocarpin injections, atropin and dionin, and subconjunctival injection of cyanid of mercury (once). Electricity had not been suggested. The consultants agreed that the vision of the right eye is hopelessly lost. Leucocythemia and acute toxemia had been diagnosed.

*Examination.*—R. E. has only perception of light; with dilated pupil the mirror gives no fundus reflex. L. E. V. = 20/20, notwithstanding a considerable amount of fluffy vitreous opacity.

The patient was advised to try galvanism and referred to his oculist, who handed him over to me.

*Treatment.*—Galvanism with cathode to right lids and current gradually increased from three to ten m. a., was used for ten minutes daily. After four days fingers could be counted to the right, and four days later in the whole field.

June 7: R. E. V. = 20/67.

June 25: R. E. V. = 20/40, temporarily. He now has annoying diplopia with divergent strabismus, but is assured that this will disappear if vision becomes normal. In April treatment was discontinued.

September 4: R. E. V. = 20/25.

May 11, 1905: R. E. V. 20/20; intermittently = 0.5 (S) at 12″. There is no diplopia. Binocular fixation in reading. Convergence = 10 m. a.

Feb. 14, 1906: R. E. V. = 20/20 fluently = 0.5 (S) at 14″. Vision somewhat clouded by a considerable amount of dust and string opacities in the vitreous. The details of the fundus are distinctly seen and appear normal except as above stated. He was advised to renew galvanic treatment.

Case 28.—Amblyopia (hysterical?) R. E. V. = 20/200, improved to 20/25; L. 20/100 to 20/25.

*Patient.*—Feb. 15, 1905. Mrs. J. F., aged 44, has never had good eyes.

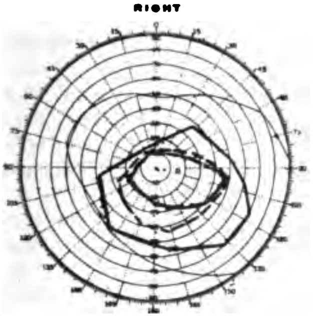

Fig. 4.—Case 28, Feb. 16, 1905. White —; blue — —; red — • — • •

*History.*—Five years ago, glasses + 2.25 for distance and + 3.50 for reading were prescribed. Her sight has been failing for nine years. She does not remember the time when she could read without a very good light. (Fig. 4.)

*General Health.*—She has had more than a dozen voluntary abortions. In 1904 she had two miscarriages without severe hemorrhage, and without affecting vision. Three years ago her sight failed very much after the loss of her husband, by accident, and since then she has been subject to heat flashes and profuse sweating hourly in the day and often in the night, accompanied by palpitation.

R. E. V. = 20/200 + 1.75 + 0.50 180° = 20/200 better; L. E. V. = 20/100 + 1.75 = 20/100.

*Treatment.*—Sinusoidal current to eyes and general electrization with the auto-condensation couch ten minutes daily.

March 2: R. E. V. = 20/100, slowly; L. E. V. = 20/30. The eyes feel stronger. The flashes, sweating, palpitation and nervousness are very much less.

**September 21: R. = 20/50; L. = 20/25. This morning she lost the sight of the right eye for an hour.**

**Feb. 10, 1906: R. E. V. = 20/25 — 2; L. = 20/25+. At times she can not see to read, and again sees only the left side of words.**

**Case 29.—Paresis left internal rectus; improvement.**

***Patient.*—May 31, 1904. Mrs. A. M., aged 25, neurasthenic, noticed three weeks ago that on looking to the right objects doubled. Exotropia 7° at 20′ and R. hypertropia 3½°.**

***Treatment.*—Interrupted galvanic current 5 m. a., negative pole to lids, ten minutes daily.**

**June 11: Exotropia 5° at 20′; 7° at 13″.**

**June 28: Exotropia 5° at 20′; R. hypertropia 2°. Diplopia only on fixation 22° to right of median line.**

**July 7: No diplopia except in fixation beyond 45° to right median line. Discontinued attendance.**

**Case 30.—Double specific choroiditis with vitreous opacities. R. E. V. 20/70, improved to 20/50, and asthenopia relieved. L. E. V. 20/20.**

***Patient.*—May 15, 1904. S. G. A., aged 40, a printer.**

***History.*—The right eye was first attacked three and a half years ago and the left eye soon after. During the past year vision has remained, in spite of much treatment, the same as at present.**

In the right fundus are numerous large fleecy opacities in the vitreous. In left fundus there are no opacities visible, but the patient complains of floating bodies before the eye. Photophobia is very intense. He is unable to do any evening work on account of pain in the eyes.

*Treatment.*—His oculist has applied galvanism to the eyes every second day during the past month and referred him to me for further treatment. The galvanism was continued, 10 m. a., ten minutes daily. July 1, 1904: R. E. V. = 20/50; L. = 20/20. He can expose the eyes freely to the light and can work all the evening with comfort.

Case 31.—Right optic atrophy. No improvement. L. E. V. 20/33, improved to 20/20.

*Patient.*—Oct. 30, 1905. Mrs. R. T., aged 36.

*History.*—Five days after a miscarriage, six months ago, she had severe supraorbital pain, especially on the right side. The right eye became inflamed and the lids swollen. She had terrible pain, fever and sick stomach for a week.

*Examination.*—The right papilla is bluish-white; the atrophy is probably toxic. Left fundus appears normal.

*Treatment.*—Sinusoidal current applied to eye for ten minutes tri-weekly. April 3, 1906: L. E. V. = 20/20.

Case 32.—Xanthelasma. Removed by electrolysis and excision.

*Patient.*—Jan. 7, 1903. Mrs. C., aged 36, has four yellow patches, two above and two below each inner canthus.

*Treatment.*—The negative galvanic needle, 5 m. a., completely removed one patch 2 in. diameter in one sitting. The current was turned on rapidly (without previous anesthesia) and the pain was so severe the patient would not consent to have even a hypodermic needle puncture for further electrolysis, hence the three remaining patches were excised under chloroform.

Case 33.—Opacities in the vitreous. L. E. V. improved from 20/70 to 20/40 and epiphora relieved.

*Patient.*—Nov. 9, 1905. S. F., aged 54. The right eye has a mature senile cataract. He has light perception; no visual field. The vision of left eye has been failing for one year. There are posterior annular staphyloma and constant epiphora. L. E. V. c — 12.00 = 20/70.

*Treatment.*—Galvanism.

Jan. 6, 1906: L. E. V. = 20/40. He does not now see specks before the eyes and has no epiphora.

Case 34.—Sequelæ of iritis. V. R. E. counts fingers at 8′, improved to 6/50. V. L. E. fingers at 3′, improved to seeing fingers at 10′.

*Patient.*—June 5, 1900. Mrs. J. B., aged 55, has had repeated attacks of iritis during the past eighteen months.

*Examination.*—R. E.: Pupil semi-dilated and irregular; floating opacities in the vitreous and capsular opacity. L. E.: Vision failed years ago. There is a large capsular opacity. Pupil normal size.

*Treatment.*—Galvanism 5 m. a. ten to fifteen minutes daily.

June 22: Twelfth treatment, R. E. V. = 6/50. L. E. V. = fingers at 10″.

Case 35.—Alopecia of the lids. Improvement.

*Patient.*—Jan. 7, 1901. Miss G. B., aged 16, five years ago had an illness and six months later the eyelashes fell out and have grown and fallen out at short intervals ever since. The baldness has now been complete for a month.

*Previous Treatment.*—Daily massage of the lids for two months and eye-drops tri-weekly for three months without any improvement.

*Treatment.*—Sinusoidal current to the lids triweekly.

May 23: Lashes have grown to one-half their usual length.

Case 36.—Amblyopia. Left eye. Vision improved from 20/120 and 3.00 (S) to 20/80 and 2.25 (S).

*Patient.*—Jan. 5, 1901. Mrs. J. M. C., aged 33, had been unable to read with the left eye for some time. Letters appeared to be surrounded by a yellow circle. Fixation is unsteady. The fundus appears normal. She feels weak and sleeps in the daytime.

*Treatment.*—Sinusoidal current to the eye triweekly.

February 16: V. L. E. = 20/80. She has improved much in strength and has no inclination to sleep during the day.

Case 37.—Asthenopia. Relieved by glasses and galvanism.

*Patient.*—Feb. 4, 1901. M. J. L., aged 33, bookkeeper.

*History.*—His eyes have never been strong. For some days he has had a constant pain in the left eye. Since 1894 he has worn glasses furnished by an optician and two oculists without much relief.

*Examination.*—He is wearing + 0.50 75° R. E.; + .75 90° L. E. Under homatropin R. + 0.50 75° = 20/20; L. + 1.00 90 = 20/20, with accommodation exophoria 2° at 20′, 8° at 13″. Prism ad. 7°, ab. 6°, convergence = 6 m. a.

Has not binocular fixation in reading without prisms of 3° base in each eye.

*Treatment.*—Cylinders with above prisms. Galvanism, three m. a., anode to lids, five times daily.

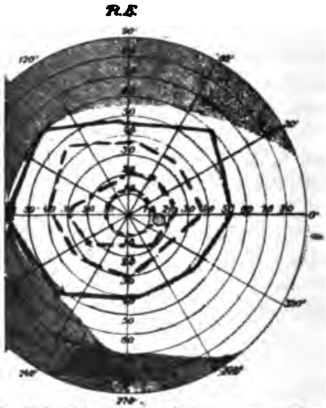

Fig. 5.—Case 39, Feb. 13, 1901. White——; blue — — — ; red — - — - ; green - - - - -

February 14: He can now read quite comfortably for two hours and has no pain in the eye.

Case 38.—Pterygium tenuis, right eye unimproved.

*Patient.*—April 25, 1901. P. V., aged 29.

*Treatment.*—Bipolar galvanic needles were used under the pterygium with 4 m. a. for two minutes.

July 18: The pterygium was the same. The positive needle was applied under the pterygium, 2‴ from the cornea, 2 m. a. for two minutes.

August 8: Positive needle was twice inserted under the growth with 2 m. a. for two minutes. This procedure was repeated August 15.

September 17: The pterygium appears the same as before the first needling.

Case 39.—Optic atrophy and retinitis circumscripta. Vision in each eye 15/200, improved to 20/50.

*Patient.*—Dec. 12, 1901. T. L. S., male, aged 54.

*History.*—His sight began to fail in February, 1900, when ill with fistula in ano, and it has gradually failed, so that for the last two months he can not read the paper.

*Examination.*—Fundi. R. E. The disc is bluish-white and blurred on the nasal edge. There is a wash-leather-colored stippling in the macular region.

L. E.: The disc is similar to the right. There are white and red dots in the macular region and also two diameters of disc up and in a similar infiltration. Color vision: He can only distinguish blue (Fig. 5). General health: The fistula was operated on and his health is now good. He is subject to chronic rheumatism.

Urine: Normal.

Since a year ago last October he has smoked one-half dozen cigars daily (more than usual) and chewed one ounce of tobacco daily up to July 1, and has not used it since. He does not take stimulants. One daughter died from tuberculosis and one from traumatic spinal meningitis. He lost two uncles from phthisis.

*Treatment.*—Sinusoidal current applied to the eyes daily.

Jan. 14, 1902: R. and L. V. = 20/200. Mercury and potassium iodid internally. Sinusoidal current continued.

January 23: R. E. V. = 20/200. L. V. = 20/120. He reads a letter now which he could not do when he began treatment.

February 18: R. and L. V. = 20/50 = 0.5″ with reading glasses.

Case 40.—Double amblyopia, ending in optic atrophy and blindness.

*Patient.*—April 12, 1901. M. K., aged 25.

*History.*—The early history of this case has been lost, except that on March 30, 1900, the V. L. E. was 20/30 and the eyes were being treated by galvanism, and on September 5 the vision was the same. The first visit was about August, 1899. In December, 1900, and in January, 1901, he was treated by a New York oculist for two months by general massage and mercurial inunction, with administration of strychnia and iron, and he thinks that vision failed somewhat.

He had been examined by several physicians and neurologists, who gave no positive diagnosis, but the diagnosis by Dr. Patrick of multiple sclerosis seems best to account for the symptoms. He had been treated by galvanism up to his visit to New York, and on returning to me in January, 1901, treatment by the sinusoidal current to the eyes daily was begun.

In reading aloud he has to study the letters and to pronounce the words at intervals of from two to ten seconds.

*Examination.*—L. E. V. = 20/30, slowly naming the letters at intervals of seconds and at times losing the line. The fundi appear normal.

May 3: V. L. E. = 20/30.

June 28: Vision is the same, with difficult fixation. Repeat.

August 3: V. L. E. = 20/50 very slowly. Sinusoidal current by galvanism to the eyes triweekly.

August 30: R. E. V. = 20/50 slowly. The fundus appears normal.

*Operation.*—Tenotomy of the right external and advancement of the right internal recti.

December 8: L. E. V. = 10/200. There is opaque white atrophy of disc. Temporal three-quarters of disc is dull white. I learned later of the sad ending of the case in total blindness.

Case 41.—Double primary optic atrophy. Vision improved from uncertain counting of fingers at 6″ to ability to read and to write her letters.

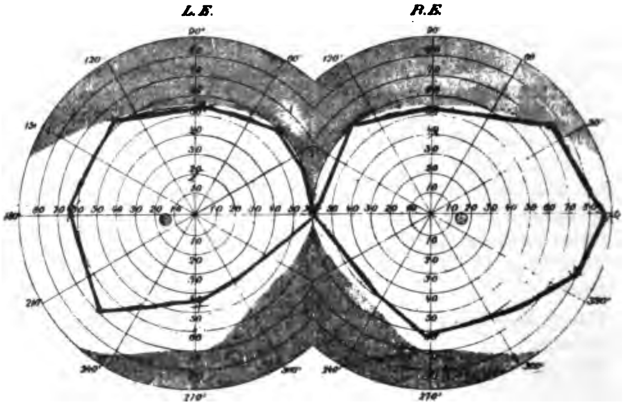

**Fig. 6.—Case 41, Oct. 10, 1901.**

*Patient.*—Sept. 3, 1901. Miss E. G., aged 36, school teacher.

*History.*—Six years previously she became very nervous on account of her inability to secure a certain position, and vision began to fail first in the left, then in the right eye. She noticed words run together and this was not relieved by glasses.

*Examination.*—Pupillary reaction to light and convergence normal. She confuses pink and gray with green, and blue with red.

R. E.: Gray-white opaque disc, reticulated at site of physiologic cup and sharply defined.

L. E.: Disc similar to right, but not reticulated. Retinal vesels normal (Fig. 6).

*General Condition.*—A few weeks before the sight failed she was thrown backward from a cart and hurt her back very much, but retained consciousness. Her memory is particularly good. She is subject to sick headache and is very nervous. Patellar reflex is normal.

*Family History.*—Her father died of nephritis at the age of 61. Her mother is 68 and healthy. She has two brothers and three sisters living. A brother, 33 years of age, commenced to lose sight at 30 and can not see to read. An oculist whom he consulted diagnosed optic atrophy and was unable to state the cause.

*Previous Treatment.*—Six years ago she was under the care of a prominent oculist for a year in his private hospital in Cincinnati. He diagnosed optic atrophy and prescribed strychnin hypodermically, baths, general massage, nitroglycerin and general faradism.

Vision did not improve and remained about the same as it is at present, that is, she can count fingers uncertainly with either eye at 6″.

*Treatment.*—Galvanism daily to eyes.

September 12: R. E. V. = fingers at 14″, L. E. V. = fingers at 12″. She read the headlines of a paper for the first time in six years.

September 30: R. and L. V. = fingers at 24″. Sinusoidal current substituted for the galvanic. The patient at this date was exhibited at the Chicago Ophthalmological Society. Dr. Snydacker, who had recently studied four years in European eye clinics, remarked he had not seen so advanced a case of optic atrophy during that time.

October 29: R. E. V. = 1/80 = fingers 4′, L. E. = 1/120 = fingers at 3′.

November 12: In fixation at 12″ the left eye diverges.

Jan. 27, 1902: R. = 1/30, L. = 1/80.

February 10: Vision the same. For some time she has been able to select her own letters from the mail and to answer correspondents. At this date her newly found faith transferred her to the care of the so-called Christian scientists.

Case 42.—Amblyopia (hysterical). R. and L. V. = 20/80, improved to 20/25.

*Patient.*—Dec. 17, 1904. M. M., male, aged 10, was referred to me by an oculist.

*History.*—He was sent from school two years previously on account of failing sight. He had been treated for one year at an eye clinic, but without improvement.

*Family History.*—His father and paternal grandfather died of apoplexy. His mother died from exhaustion.

*Examination.*—R. Fundus: Physiologic cup is three times usual size and the vessels emerge very near the nasal side of the disc.

L. Fundus: Similar to right. The boy is exceedingly nervous. The case has been diagnosed as hemeralopia without pigmentation, but night blindness is not complained of and there is no degeneration of the retinal vessels. The small field of vision without optic atrophy is characteristic of hysterical amblyopia, as is also a frequent diplopia.

*Treatment.*—Sinusoidal current applied triweekly.

March 1: R. = 12/10, L. = 5/100.

April 20: R. = 8/100, L. = 6/100. The fields are concentrically contracted to 20°.

June 24: R. = 14/100, L. = 10/100.

November 28: R. = 14/100, L. = 14/100. Repeat.

December 16: R. = 20/50, L. = 20/67.

Feb. 15, 1906: R. E. = 20/30, L. E. = 20/30.

April 7: R. or L. V. = 20/25.

Case 43.—Traumatic optic atrophy. V. L. E. = light perception; not improved.

*Patient.*—April 27, 1904. F. B., aged 16, struck his left eye two weeks previously by running against the tip of an umbrella. The whole disc is opaque white.

*Treatment.*—Sinusoidal current applied to the lids daily to bi-weekly.

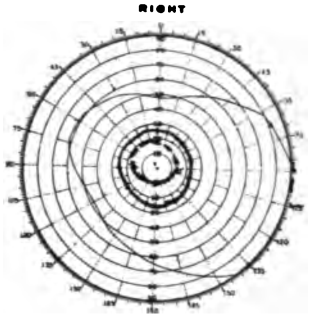

Fig. 7.—Case 41, April 8, 1906. White ——; red and blue — — —

May 3, 1905: There is no improvement in vision and the eye has acquired a divergence of 18°.

SUMMARY OF CASES TREATED ELECTRICALLY.

*Optic Atrophy.*—Fourteen patients, 23 eyes. In 5 eyes in which vision = light, 40 per cent. were improved. One to seeing hand movements and one to 20/67.

In 18 eyes in which vision = form. Sixty-four per cent. were improved. Four, 60 to 125 per cent.; two, 300 per cent.; three, 500 per cent.; one, 1,500 per cent.; two from seeing fingers to reading. In six there was no improvement.

*Vitreous Opacities.*—Seven patients, 12 eyes. In 5 eyes vision = light. One improved to counting fingers at 6 inches; one was unimproved. In 12 vision = form. Ninety per cent. were improved: Seven, 40 proved: Four, 20 to 100 per cent.; six, 200 to 700 per cent.

*Amblyopia.*—Seven patients, 10 eyes. All were improved: Four, 20 to 100 per cent.; six, 200 to 700 per cent.

*Sequelæ of Iritis.*—Two patients, 4 eyes. All were improved: One from light perception to 20/70; one, 100 per cent.; two, 200 per cent.

*Intraocular Hemorrhage.*—One eye. Vision improved from light to 20/20.

*Retinitis Pigmentosa.*—One patient, one eye. Improved 100 per cent. One eye was not improved.

*Retinal Thrombosis.*—One eye. Vision was improved from fingers at 14′ to 6/15 and 0.5 at 12 inches.

*Sequelæ Central Retinitis.*—One patient, two eyes. No improvement.

*Asthenopia.*—Three eyes. Recovered.

*Xanthelasma.*—Two patients. Recovered.

*Paresis of Ocular Muscles.*—Two patients. One recovered and one was much improved.

*Alopecia of Lids.*—One patient, improved.

*Nictitation.*—One patient. Recovered.

*Pterygium.*—One eye. No improvement.

The recovery of cases Nos. 1, 2, 21, 27, 41, 14 and 22 deserve to be emphasized as phenomenal, especially since in all, except the last two, the patients had been previously treated without improvement.

Thus, contrary to the contention of the erudite and lamented Noyes, and "most oculists" (Burnett), electricity does seem to justify its claim to usefulness in ophthalmic practice.

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ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# THE VALUE OF X-RAYS IN OCULAR THERAPEUTICS.*

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**PHILADELPHIA.**

Amid the illuminating advances that have characterized the rapid progress of medical science during a trifle more than the last decade, the spectacular and beneficent discovery of Professor Roentgen, of Wurzburg, occupies a position of acknowledged preëminence.

The classical papers which first startled the world of science have been followed by a flood of literature emanating from hosts of enthusiastic workers from almost every corner of the globe, and while the hopes and promises have to some extent failed of materialization yet the amazing therapeutic results that have been wrought up to the present moment should abundantly merit our profound appreciation and study.

Ophthalmic science has had its quota of fleet-footed workers, eager to develop the far-reaching possibilities of the newly discovered form of radiant energy. It is our purpose to institute an inquiry into the results thus far achieved and to attempt to define the present position of the *x*-ray therapeutics as applied to several important branches of ophthalmology.

When we consider the *x*-ray from a therapeutic standpoint we are, according to Freund,[1] dealing with the fol-

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*** This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.**

**[1] Freund: "Elements of General Radio-Therapy," Vienna, page 328.**

lowing forces emanating from the surface or within a vacuum tube in action: (1) heat, (2) ozone, (3) cathode rays, (4) ultra-violet rays, (5) rays composed of material particles, (6) Roentgen rays, (7) spark and brush discharges from the high tension, electric accumulation on the surface of the tube, (8) electric and electro dynamic waves, (9) waves of unknown character. Stern[2] believes the only rays that need to be considered are the *x*-rays, the unknown rays and the electric discharges from the surface of the tube.

The histological sequelæ of the *x*-ray application (Stern) are stimulation of the vaso-constrictor nerves of the blood vessels, paralysis of these nerve filaments accompanied by vascular dilitation, edema, the result of paralysis carried to a higher degree, and finally complete nerve paralysis, accompanied by destruction of tissue.

It is impossible in so brief a communication to place before you a complete summary of the brilliant work which the electro-therapeutist has achieved, but many opinions of value have been gleaned from the copious, and at times, polemic literature of the last few years. In answer to a communication addressed to many of the foremost ophthalmologists and *x*-ray experts of our country, I am able to present to you a number of hitherto unpublished opinions regarding the results of the application of this form of therapy to disease of the eyes and ocular adnexa. In the discussion to follow I hope that the various and at times divergent views expressed may be crystallized into definite and unfailing methods of technic that may make the amazing results claimed by certain observers a usual sequel of the application of this form of energy.

In a malignant disease of the eyelids and adjacent structures, radiotherapy (because of the favorable character of the resulting cicatricial tissue) finds one of the most satisfactory fields. When Steinbeck,[3] of Stockholm, exhibited before the Swedish Medical Society, a case of epithelioma, which he had cured by means of Roentgen therapy, a stimulus was given to this important work, which, notwithstanding its triumphs, must still be conceded to be in its incipiency.

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[2] Stern: "Practical Results Accomplished by Radiant Energy," New York Med. Jour., March 10, 1906.

[3] Steinbeck: Quoted from "*X*-Rays in Cancer and Other Diseases," by Richard J. Caven.

My experience in a considerable group of epitheliomas, involving the eyelids and contiguous skin structures, and varying in size from a base of 10 mm. in its longer diameter to an extensive ulceration, at times embracing half of the upper and lower lids, and extending well on to the bridge of the nose, several of which were totally inoperable, has been so uniformly satisfying that I am accustomed to leave little doubt in my patients' mind regarding the certainty of a cure. In only one such case that has come under my observation was there any tendency to a recurrence at the end of about eighteen months. This was subjected to a few further treatments and has remained in perfect condition through the succeeding year.

Mayou[4] and D. Walsh (London) presented a most promising series of results before the Roentgen Society, Dec. 2, 1902, the former claiming that all cases of so-called rodent ulcer of the eyelids can be cured. The inflammation which can be produced by the *x*-ray varies, according to these authors, from a mild leucocytosis (stimulation) to an absolute destruction of tissue. Added experience seems to emphasize the opinion, early expressed, that this profound change is largely superficial, and is not produced by the rays that penetrate deeply. It is the function of the leucocytes to break up and remove all irritating substances, or to encapsulate and thus render them innocuous.

One of our foremost authorities, William Allen Pusey[5] (Chicago), reports having treated several cases of epithelioma, in which there was no involvement of the deeper orbital tissues, and all resulted in cure where sufficient treatment was permitted. No relapses have occurred, and some of the cases were treated about three years ago. John Green, Jr.,[6] St. Louis, Mo., also concludes that in epithelioma and rodent ulcer of the eyelids, *x*-ray therapy surpasses all other methods of treatment and can be relied on to cure all such cases.

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[4] Mayou: "The Use of *X*-Rays in Ophthalmic Surgery," Archives of the Roentgen Ray, January, 1903.

[5] Pusey, W. A.: "Report of Cases Treated with Roentgen Rays," Chicago Medical Recorder, April, 1902. For Dr. Pusey's technic see Chicago Medical Recorder, April, 1900, and Journal of Cutaneous and Genito-Urinary Diseases, July, 1900.

[6] Personal note.

Sweet[7] believes that it is no longer right to resort to plastic operations in these two conditions, basing his judgment on the successful results of 18 out of 20 cases treated.

John E. Weeks[6] (New York) regards the *x*-ray treatment of very great value in epithelioma and has placed at my disposal the notes of one private case of epibulbar epithelioma of very great interest.

**The patient, a man aged 54, had a growth occupying the inner half of the ocular conjunctiva to the caruncle, and involved about the inner third of the cornea.**

**Diagnosis was confirmed by microscopic examination.**

**About 100 *x*-ray exposures were given, extending over a period from March, 1905 to January, 1906; the exposures averaging 7 minutes each at 10 inches from the Gundelach anticathode using a tube of medium tension. Patient is virtually well. Vision 20/40. Tissues of the globe have not suffered. The exposures were made through a tube 1¼ in. in diameter. There was no other protection.**

De Schweinitz[6] (Philadelphia) has had four cases of "entire and rapid cicatrization" with no relapses. In two additional cases the results were entirely negative, or possibly the condition was aggravated. In one of the latter, excision was practiced with subsequent application of the rays, without recurrence. De Schweinitz concludes the rays should be tried for a certain period, and if the results are not good, then excision with or without plastic operation should be practiced.

Charles Lester Leonard[6] (Philadelphia) whose experience has been extensive in treatment of epitheliomas and various skin lesions involving the eyelids, regards it as uniformly and permanently successful. Baker[6] (Cleveland) writes that he has had five cases of rodent ulcer with perfect recovery. One case of special interest has been under observation for ten years, but all this time the disease was slowly progressive, not only the eye, but the cheek and temple were involved. The eye was enucleated and, later, *x*-ray applications were made for a year or more less regularly, resulting in complete cicatrization with no evidence of recurrence at the end of four years. In a sixth severe case in which both *x*-ray and radium were used, a complete cure has been effected, the curative agent being, in Baker's judgment, the Roentgen ray. In eight cases of epithelioma, the results have been entirely satisfactory, although in most of the cases the knife was used and followed by the *x*-ray. There have been no recurrences. Baker had two cases of lupus involving the eyelids that have been "very greatly improved if not entirely cured by the *x*-ray."

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[7] **Sweet, William M.: "Roentgen Ray Treatment of the Eye and Its Appendages," Medicine, April, 1904.**

Hermann Knapp[6] (New York) has seen "four temporary results in epithelioma and the like." Stevenson[6] (Albert Lea, Minn.) has used the *x*-ray with success in treatment of lupus of the eyelids only. Newcomet[6] (Philadelphia) advises me that he has treated about 30 cases, few of which have shown any disposition to recur.

The names of a host of foreign and home workers in ophthalmologic or electrotherapy lines could be added, if additional testimony were needed, among them Hamer,[8] Hall,[9] Darier[10] and Bettremieux;[11] in our own country, Taylor,[6] Dixon[6] and Marple[6] (New York), St. John[6] (Hartford), Holt[6] (Portland), Black[6] (Milwaukee), Wescott[6] (Chicago), Howe[6] (Buffalo), Schamberg,[6] Hansell,[6] H. K. Pancoast,[6] S. Lewis Ziegler[6] (Philadelphia). Schamberg's case is of considerable interest, as the case involved not only the lids, but the conjunctiva as well. A perfect cure was effected without sign of recurrence at the end of two years.

S. C. Ayres[6] (Cincinnati) has had one case of epithelioma of outer and lower margin of right cornea of six years' duration. It was curetted, but soon recurred. Under *x*-ray treatment, pain was relieved and the condition improved. He was not kept under continuous treatment, and later increase in the growth compelled enucleation.

Bulson[6] (Fort Wayne) advises me that in four cases of extensive carcinoma two were cured, a third probably cured, and the fourth did not continue treatment. Woods[6] (Baltimore) believed the rays successful in preventing a recurrence after an orbital evisceration for extensive carcinomata.

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[8] Hamer, J. F. X.: "Carcinoma palp. inf. behandel med. X-straalen," Ned Tijdskrift v. Geneeskunde, 1904, No. 12.

[9] Hall, Edward: "Rodent Ulcer, Treated by the *X*-Rays," British Med. Jour., Jan. 10, 1903.

[10] Darier, A.: "Introduction à l'étude des rayons X en therapeutique oculaire," La Clin. Ophth., July 10, 1903.

[11] Bettremieux (Roubaix): "Rayons X en therapeutique oculaire," Ibid.

Würdemann[6] reports a case of carcinoma of the orbit beginning in the skin of the external canthus. The operation consisted of exenteration of orbit and resection with partial removal of malar, superior maxillary and orbital process of the frontal bones. The patient was treated about two years by $x$-rays several times a week; a suspicious sore was removed by secondary operation, and the result was complete cure with full lining of orbit by skin.

## X-RAYS IN SEVERE CASES.

As illustrative of the curative possibilities of the rays in the more extensive carcinomatous involvement of the orbital and adjacent tissues, it is only necessary to refer to cases of which this one reported by Dr. Pusey,[5] of Chicago, is a type:

> *Deep Carcinoma in the Orbit.*—Patient of Dr. Wm. H. Wilder, treated by Dr. Pusey.
>
> The growth involved all of the structures in and around the orbit, and the terrific intracranial pain seemed to leave little doubt of meningeal involvement.
>
> After nearly two months of treatment and a resulting $x$-ray burn coincident with increasing pain, the case was regarded as hopeless and discharged. About six months later it was found he was still living; the mass had shrunk and lids would close. He is free from pain, eats and sleeps well.

Of the 10 cases so carefully reported by Chas. S. Bull,[12] two were extensive carcinomata. One was a case of the eyeball and orbit in which operation was advised, but declined. The case was cured by twenty-seven $x$-ray exposures. The other was a case of deep-seated carcinoma involving the nose, eyelids and orbit, likewise perfectly cured by thirty-four exposures.

As noted by George C. Harlan[6] (Philadelphia), J. W. Pancoast[6] and many others, with whom probably all of us are in accord, it must be remembered that in many of the deep-seated growths of the carcinomatous type the rays have totally failed to arrest the disease, but even in such cases there is little doubt of the pronounced anodyn effect of the exposures, and, while, as suggested by Nelson Black[6] (Milwaukee) and others, the deeper the orbital involvement the less favorable result can be expected, yet the estimate of Jackson[6] (Denver) that it is of great value even in the more extensive types of orbital carcinoma can be abundantly maintained.

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[12] Bull, Chas. S.: "The Treatment of Inoperable Cases of Malignant Disease of the Orbit."

### SARCOMA.

In a previous paper[13] I considered the use of Roentgen therapy in attacking this form of malignant neoplasm. Reference was made to the remarkable result in L. Webster Fox's case of inoperable sarcoma involving the orbit and accessory sinuses apparently cured by fifty exposures to *x*-ray. A daily treatment of five minutes' duration, with a high vacuum tube placed at 10 in. distance, containing a current of 4 amperes, was maintained for 4 weeks, the frequency of the treatment then being reduced on account of an excessive erythema.

In the same paper the gratifying reports of a number of cases of sarcoma *x*-rayed by Leonard and by Pfahler, of Philadelphia, involving the face, neck, lip, nostril and antrum were accepted as giving promise of similar brilliant results with improved technic, when the growth involved the orbit and surrounding structures. The immediate application of the method was suggested before radical operation was attempted. If unsuccessful in removal of the growth, Leonard, who has had a very wide experience, claims that its virulence will be decreased and the dangers of metastasis lessened. Other methods of attack were carefully considered in the event of failure with the *x*-ray.

I will refer now to a few additional reports of cases treated by the rays as introductory to a further discussion of this important subject.

Beclere[14] reports the case of a patient affected with sarcoma of the floor of the orbit who was cured by *x*-rays. The disease had lasted four years. Two operations had been performed, the last one including removal of the eye. All other methods of treatment had failed, but improvement set in as soon as radiotherapy was employed. Histologically, the tumor was found to be a malignant sarcoma. Beclere reports an additional case of orbital sarcoma cured by *x*-rays.

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[13] Ring, G. Oram: "Orbital Sarcoma, with Report of a Case and a Discussion of Radical Operation, X-ray Therapy and Electrochemical Sterilization." N. Y. Med. Jour., June 10, 1905.

[14] Beclere: "Sarcome de l'orbite gueri par les rayons-X," Gaz. des Hôp., June 14, 1904.

Kienbock[6] reports a sarcoma cured by *x*-rays. This case is of very unusual interest. A growth having appeared in the nose seven years before, in spite of operations oft repeated, had invaded the adjoining structures and produced exophthalmos on both sides with subsequent optic atrophy. Pain ceased after the first treatment, and after thirteen applications the growth (an endothelial sarcoma) entirely disappeared. Eyes resumed their normal appearance and vision partly returned. Grossman[6] reports a similar case which had almost entirely disappeared under the *x*-rays.

Theobold[6] (Baltimore) has had one case of marked exophthalmos (unpublished) with the diagnosis of inoperable sarcoma of the orbit—a diagnosis in which two other surgeons concurred. Under the *x*-ray treatment the case rapidly improved and after a lapse of seven months seemed to be cured. Pfahler[6] advises me that he has treated three cases of primary orbital sarcoma, with resulting disappearance of the growths. A fourth case, which was recurrent, showed no ultimate improvement.

When to these reports we add the case of Mosely,[15] orbital sarcoma, that of Pratt,[15] melanosarcoma of orbit, that of Harper,[16] melanosarcomatous pigment areas on the sclera, and that of Fox,[17] true sarcoma of the lids, all cured by radiotherapy, we surely have abundant reason for some satisfaction at the results already achieved.

Many observers have utilized the rays successfully in preventing a recurrence after the removal of malignant orbital growths, notably sarcoma, and the recent experience of Wescott[6] (Chicago) and Chas. S. Bull[12] and Marple[6] (New York) will serve to bring to our attention this important phase of the subject. Wescott advises me that he exenterated a case of orbital sarcoma, and, feeling positive that all of the disease was not removed, subjected the patient to *x*-ray treatment for three months. There was no evidence of recurrence at the end of one year. On the other hand, Bull, in his painstaking report of eight cases of orbital sarcoma, has not found radiotherapy of value as a curative agent either before or after operation. He, however, believes it distinctly effective in the relief of pain. Marple has had one case of orbital sarcoma with exenteration of the orbit. *X*-ray was used in the effort to prevent a recurrence, which it failed to do. In one of my own cases it seemed to prevent a recurrence *in loco.*

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[15] "Radiotherapy in Ophthalmology," quoted by Allen.

[16] Harper: "Melanosarcomatous Pigment Areas on Sclera," Amer. X-Ray Jour., 1902, p. 1164.

[17] Quoted by Würdemann.

## TRACHOMA.

In the treatment of the nodular formations or masses of round-cell infiltration of the conjunctiva, known as trachoma, the ophthalmologist has found one of his most difficult problems. The various remedies used may be classed under the heads of chemical or mechanical irritants. The excessive and often damaging cicatricial tissue remaining after the application of the chemical irritant classes this method as far from ideal.

The rolling, brushing and other allied methods are of unquestioned value, but the cures are frequently incomplete even with the added chemical treatment. The cure is wrought, in part, by mechanically removing the diseased masses and, in part, by the induction of a leucocytosis with subsequent cicatrization. Since the disease is probably allied to lupus, it may be caused by an undiscovered bacillus, the destruction of which by the methods noted results in pronounced betterment.

Stephen Mayou[18, 4] lauds most highly the results achieved by *x*-ray treatment of this condition, claiming (1) less deformity of the lid after treatment, (2) it is practically painless, (3) the pannus clears more thoroughly. His first case, presented before the London Ophthalmological Society early in 1902, was apparently the initial application of the method. "Instead of the white puckered conjunctiva gained by other methods, a supple non-contracted, non-scarred conjunctiva, with no obliteration of the fornices," was noted. In every one of 15 cases a perfect result was achieved. No burning of the globe occurred in any case. Two-minute exposures were given from four to six successive days, followed by a week's rest; then came semi-weekly exposures until slight photophobia began. When granules disappear, the treatment should cease, as the infiltration

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[18] Mayou: "The Treatment of Trachoma by X-Rays," Trans. of the Ophth. Soc., London, S. 10.

induced by *x*-ray will be some weeks in subsiding. The patient is seated 9 inches from the anode with a moderately soft tube and a current of 6 amperes. The metal mask formerly used is now discarded, as the patient is not exposed sufficiently to get any skin reaction.

Stevenson and Walsh[19] selected severe cases which ordinarily required a very prolonged treatment by old methods, and they were cured in a few weeks. They report equally good results in a case treated less than two months with a high frequency current. After twenty-three painless applications of the brush discharge from a vulcanite electrode connected with a Cox's d' Arsonval apparatus, a disease disappeared that would have lingered on two or three years under ordinary treatment.

Walsh[20] (London) has treated four cases of severe double trachoma, with complete cure in two and marked improvement in the remaining two. Good effects were the same if lids were closed or everted.

Vassutinsky[21] obtained favorable effects on trachoma by means of the Roentgen rays. These rays diminished the infiltration, caused the disappearance of the granulations and of the pannus, and produced a pronounced improvement in the subjective signs of the malady. As a rule, however, trachomatous granulations disappeared but slowly under the influence of Roentgen therapy. The rays proved to be harmless in treating the eyes, no evil effects were noted in any case, nor was pain experienced by the patients. The author thinks that the rays are of service in cases in which ordinary methods of treatment fail.

Ruggero Pardo[22] reports two cases of trachoma which derived benefit from the application of *x*-rays.

CASE 1.—The patient, aged 60, had suffered from double trachoma for three years. In the right eye was dense pannus, abundant catarrh, and congested iris. The left eye was similarly affected, but to a much less degree.

CASE 2.—The patient, aged 14, had had trachoma two years. A Crookes tube with a spark about 700 mm. was used at a distance of 45 to 30 cm. for four to ten minutes at a time. Only one eye was treated, the other being carefully protected with a metallic shield. About six applications were made in each case at intervals of three days. As a result of the treatment the conjunctiva became smoother, the secretion ceased, the pannus cleared, and there was marked improvement in vision in the first case. In the second case many of the tarsal follicles disappeared, the secretion diminished, and there was considerable improvement in the subjective sensations.

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[19] Stevenson and Walsh: "On the Curative Treatment of Trachoma by the X-ray Tube Exposure," Medical Press, 1903.

[20] Walsh: Medical Brief, No. 31, 673, 1903, also Lancet, No. 10, p. 237, 1903.

[21] Vassutinsky: "Roentgen Rays in Trachoma," Roussky Vratch, Jan. 8, 1905.

[22] Pardo: "Cases of Trachoma Treated by Roentgen Ray," Gaz. d. Ospedali, Milan, No. 13, p. 1193.

Geyser[23] maintains that a few exposures, six to eight, will suffice to bring about a perfect cure. An important consideration is to cause absorption and stimulate normal nutritional processes; nothing seems to answer the purpose any better than the direct contact of the tissues with a high-frequency vacuum tube generated by a static machine or *x*-ray coil. Complete details of technic are given in the article.

Horniker and Romanin[24] (Trieste) report the history of three successful cases of trachoma treated by *x*-rays. The methods of Mayou, Cassidy, Rayne and Pardo are compared. The method of Mayou of applying the rays directly to the everted lids was selected, as the strength of current did not have to be judged with such exactness in order to prevent skin lesions. Cassidy and Rayne applied the current to the closed lids. Notwithstanding the care exercised, dermatitis of the hands developed and, for the purpose of holding open the everted lids, Romanin devised an instrument which is carefully described and which is said to make the performance perfectly comfortable to physician and patient. He claims that one single advantage of the Pardo method which makes prominent the retrotarsal fold can likewise be obtained by his instrument by placing a compress behind the everted lid and by turning the lid holder by screws. Although eminently successful in three cases, Horniker does not attempt to decide on its final value until a larger mass of authoritative material shall have been collected.

The investigation of Heineke[25] as to the results of the application of the *x*-rays in disease of the spleen and other lymph organs in rabbits, more particularly in leukemic conditions, pointed to a destruction of lymphocytes in the follicles.

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[23] Geyser, Albert C.: "The Successful Treatment of Eighteen Cases of Granular Lids by the X-ray and High Frequency Vacuum Currents," Jour. of Advanced Therapeutics, May, 1904.

[24] Horniker and Romanin: Zeitft. f. Augenhlk., 1904.

[25] Heineke: "Ueber die Einwirkung der Rontgenstrahlen auf innere Organe." Munch. med. Wochft., 1904, p. 785.

Buschke and Schmidt[26] found a cessation of proliferation of cells in kidneys and testicles, which confirmed the earlier findings of Albers Schonberg[27] concerning azoospermia. These results induced Stargardt[28] (Kiel) to investigate the results of the rays on trachoma mass, which is essentially composed of lymph follicles.

Kuhnt (Konigsberg) has practiced excision of the upper retrotarsal folds for many years. It was at his clinic that Stargardt was permitted to *x*-ray the folds before excision. In the application the method of Kienbach was modified; that is to say, one long exposure (twelve minutes with soft tube distance of 5 cm.). Stargardt believes there is no danger to the conjunctiva in these exposures. Microscopically the principal change was noted in the follicles. In one instance the retrotarsal fold was excised in 16 hours; in a second, 30 hours; in a third, in 14 days. In the first and second cases highly colored masses were scattered over the whole follicle which were regarded as the remains of destroyed nuclei. These masses varied in shape and size from that of a lymphocyte to that of the smallest particle. They were mostly strongly colored with the stain, a few less intensely so. though very scarce some were non-stained. These masses lie mainly between the cells, partly in the phagocytes. The phagocytes are similar to the Villard type. Their number is increased. They are unevenly distributed over the whole follicle and do not show the regular arrangement usually seen in trachoma. In addition to the increase of phagocytes, a strong increase in Villard's giant cells was also noted. The giant cells are very plentiful, and we also find from three to six large black colored nuclei which lie in a mass of plasma substance. The decrease of threads produced by the segmentation of cells was very striking.

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[26] Buschke and Schmidt, E.: "Tierversuche über die biologischen Wirkung der Rontgenstrahlen," V. Inter. Dermatologen-Kongress, Berlin.

[27] Albers Schonberg: "Ueber eine bischer unbekannte Wirkung der Rontgenstrahlen auf den Organismus der Tiere," Munch. med. Wochft., 1899.

[28] Stargardt, K.: "On the action of Roentgen Rays on the Trachoma Follicle," from the Eye Clinic in the University of Königsberg in Prussia, Zeitft. f Augenhk., 1905.

Cassidy and Rayne[29] (Baltimore) report the case of an artist's helper who suffered for nine years from granular lids.

Patient had been operated on twice with grattage and twice by avulsion. The usual astringent and caustic treatment was also exhausted. Treatment was begun November 8, 1902, through closed lids. Cautious tentative exposures of three minutes each, separated first at intervals of ten days, then five days, then tri-weekly exposures were given at a distance of 12 inches, and a spark gap of one-sixteenth of an inch. These treatments caused excessive lacrimation which diminished on successive exposures and finally ceased. By the thirty-fifth exposure both eyes were free from trachomatous granules. The patient's lids are now little inflamed and are not thickened. The mucous membranes are still red, but free from swelling and discharge. There are absolutely no trachomatous granules, photophobia is entirely absent, and the patient uses her eyes constantly without discomfort.

The effect, according to three writers, is neurotrophic. Normal tissues are stimulated to a new vigor, and pathologic tissue, always being of less resistance, assumes a retrograde metamorphosis.

At a regular meeting of the Philadelphia County Medical Society, Nov. 23, 1904, W. S. Newcomet and J. P. Krall[30] (Philadelphia) exhibited a girl of eighteen who had been subjected to all the operations for the cure of trachoma without success.

Patient was treated with the *x*-ray from July, 1903, until January 1, 1904. The inflammatory reaction was so intense that it was thought better to abandon the treatment, Later, however, it was found that she could count fingers at close range. The cornea of the eye was entirely clear and only with special illumination could fine blood vessels be seen. The eye not treated with the *x*-ray showed all the symptoms that the treated eye formerly exhibited. The condition of the patient had been present since infancy, and she had been unable to see across the room. Treatment was given every other day for five minutes for about six weeks, when a burn developed and treatment was withheld. Newcomet believed the result to be due to the accidental burn produced in the course of treatment.

H. N. Bishop[31] (London) gives the results of electrical treatment of trachoma at the Middlesex Hospital.

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[29] Cassidy and Rayne: Jour. of Eye, Ear and Throat Diseases, 1903.

[30] Newcomet and Krall: Trans. Philadelphia County Med. Soc., Nov. 23, 1904.

[31] Bishop, Harman N.: "Electrical Treatment of Trachoma," British Med. Jour., Aug. 26, 1905.

Cases had been treated with well equipped apparatus, with rays, high-frequency currents, and radium. With regard to the *x*-rays he explains that there were two sets of rays emanating from the tube, (1) the *x*-rays proper, (2) the overflow rays that cause the severe burning of the skin which sometimes occurred. The former of these rays were used. Four cases of trachoma were treated in this manner. Two were young women. In one, fifty applications were made in five months. The right eye showed changes that might reasonably have been produced in this time without treatment, while the left, which was at first unaffected, steadily got bad. The disease subsequently cleared up in the usual manner with bluestone. None of the three other cases did any better. The seven cases treated with high-frequency currents did not improve at all.

Kassabian[6] (Philadelphia) has treated four cases in his work at the Philadelphia Hospital, two acute and two chronic. All of the photophobia and lacrimation markedly manifest in the acute cases disappeared after four or five exposures and the results achieved in all four cases were so satisfactory that Kassabian believes we have in the *x*-ray a most valuable curative agent, if properly used. Kassabian's technic in treating cases of trachoma consists in covering the Crookes' tube with a dark cloth and darkening the room. He uses adhesive plaster to fix the lids and expose the surface of the eye, to prevent the burning of the nurse's or assistant's fingers. He covers the face with a leaden sheet and treats one eye at a time through an aperture in the lead. Rapidity of action is obtained by getting the patient to keep the eye open while under treatment. There is less danger of burning the cornea than there is to the skin of the eyelid, but should a slight corneal haziness result it quickly disappears and a corneal scar will be absorbed.

W. Franklin Coleman[6] (Chicago) says that in 12 cases of trachoma his results in the treatment have been so uniformly favorable that he would not consider any other method. Coleman's first case was exposed to the *x*-ray July 1, 1903. The disease was of 20 years' standing. A high-frequency tube was used with ten minutes' exposure three times weekly. A perfect recovery resulted in six weeks. He now uses a two and a half inch spark, ten minutes' exposure at six inches with low tube, with lids closed and no mask. Every case treated has resulted in perfect cure.

Ayres[6] (Cincinnati) reports one severe case of trachoma with marked hypertrophy of conjunctiva. Three other cases, trachoma, less severe, all resulted in perfect cure. Pfahler[6] (Philadelphia) has treated 15 cases of trachoma with *x*-ray. All showed improvement, a few decided improvement. He believes the rays should be used after accepted methods have been given a fair trial. He has never seen any harm result to the eye from the exposures.

Schamberg[6] (Philadelphia) has treated one case at the Polyclinic Hospital with most satisfactory results. There were pronounced vegetations on the tarsal conjunctiva. Pain was relieved and the vegetations disappeared. In this case the eyelids were averted and the rays applied directly to the granulation. Twenty-five treatments of five minutes' duration were given twice weekly.

Jackson[6] (Denver) advises me that in his experience *x*-ray does some good and may cure acute cases, but not more quickly or certainly than older methods. It has not cured or permanently benefited the bad cases. L. Webster Fox[6] (Philadelphia) has utilized *x*-ray, but not with encouraging results. Fox prefers the older recognized remedies. Suker[6] (Chicago) states that the *x*-ray has given him no results or even encouragment in treating trachoma of any type. de Schweinitz[6] (Philadelphia) regards the results as fairly good in the few cases in which he has used the method, but considers his experience too limited to render an expression of his opinion of value. Ordinary therapeutic agents or operative measures have served him as well. With improved technic and exact dosage, the measure offers a prospect of success and should be given the fullest trial. His personal experience is limited to two cases, neither of which was as much benefited as it would have been under ordinary treatment in the same period. He has seen two cases in the care of colleagues in which the results were somewhat better than those that follow the usual applications and surgical procedures. Sweet[6] (Philadelphia) has treated a number of cases of trachoma by the *x*-rays, but did not consider the results to be any better than could be secured by the usual local measures.

### VERNAL CONJUNCTIVITIS.

The utterly unsatisfactory results of all forms of treatment of this extremely intractable type of conjunctival hypertrophy determined Allport[32] (Chicago) to test the *x*-ray in a case of characteristic palpebral type.

The patient, a young lady, aged 19, living in a refined and wealthy environment, gave a history of seven years' experience with the disease. The growths were first amputated, then subjected to about eighty *x*-ray applications in less than three months. Photophobia, redness, itching and irritability were removed at once, and the patient apparently perfectly cured, since she has gone through two subsequent summers without any recurrence of the disease.

The case was *x*-rayed by Pusey, and the diagnosis confirmed by Casey Wood, Woodruff and Guilford of Chicago.

Pusey[6] has had one additional case in which the disease was cured. William Campbell Posey[6] (Philadelphia) believes that *x*-ray exerted decided influence on the course of the disease. He has kindly placed at my disposal a brief note of his case.

The patient, a man, aged 35, came to the Will's Eye Hospital in May, 1905, with the statement that for two years preceding, during the warm months, his eyes had annoyed him greatly with itching and smarting, increased lacrimation and great sensitiveness to light. These symptoms had subsided with the appearance of cold weather again in the autumn. On examination, it was noted that the patient was suffering from a typical attack of vernal conjunctivitis of the palpebral type, the conjunctiva being greatly infiltrated and whitened, and there being a number of flattened granulations in the conjunctiva of the upper lid. The bulbar conjunctiva was unaffected.

Antiseptic washes of boracic acid and cocain, and solutions of adrenalin, in strengths varying from 1-10,000 to 1-5,000, were prescribed. The patient was instructed also to report to the Polyclinic Hospital for the administration of the *x*-rays. These were continued during the summer months, the applications being made twice a week, and each seance lasting about five minutes. Subjective symptoms were apparently greatly influenced by the rays, for notwithstanding that local treatment was interrupted for a time, the itching and smarting sensations were much less in severity. After some weeks treatment the follicles underwent a change and became markedly less pronounced. While during the preceding August and September the patient had suffered great annoyance, these months were passed in great comfort. No deleterious action from the rays, either on the eye or adnexa, was manifested at any time.

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[32] Allport: "A Case of Vernal Conjunctivitis," Ophthalmic Record, October, 1903.

Zentmeyer[6] (Philadelphia) has had two cases of vernal conjunctivitis treated by means of $x$-ray by Sweet, one resulting in perfect cure, the second in marked improvement.

In the first of Zentmeyer's cases, a boy of 15, the affection was in both eyes, but worse in the right. The upper lids were studded with typical flat granulations. At the limbus above and to the temporal side were the nodular swellings overlapping the cornea. When treatment was stopped, a year ago, the granulations had entirely disappeared from the lids, but a few of the nodules persisted at the limbus. He passed through last summer without any discomfort and at the present time the palpebral surfaces of the lids are normal. The few nodular swellings still remain, but have not increased during the year. The boy was so satisfied with his improvement that he did not return for further treatment.

Sweet[6] had two remaining cases, which disappeared from treatment after the subsidence of acute symptoms. De Schweinitz[6] (Philadelphia) has utilized $x$-ray in only one case of vernal conjunctivitis. The treatment was of short duration, and the negative result ought not to be utilized in any estimate of the value of this agent in treating this form of conjunctival diseases. Suker[6] (Chicago) has had sufficient experience to convince him that $x$-ray treatment of vernal conjunctivitis is of positive value. Jackson[6] (Denver) believes that $x$-ray sometimes diminished the discomfort, but prolonged trial has shown no curative influence.

## CONGENITAL NEVI.

At this writing I am having treated a case of nevus of the left upper eyelid, which had attained considerable proportions. There is apparently being effected a rapid cure.

Stewart (Thomas S.) and Given (Ellis V. W., Philadelphia) advise me they have likewise had several apparent successes with the rays.

## CHRONIC CONJUNCTIVITIS.

By courtesy of Kassabian[6] (Philadelphia) I am enabled to add to the various types of cases amenable to $x$-ray treatment that of chronic conjunctivitis.

The patient, a man, aged 35, had suffered for seven years, with an obstinate type of this condition. Every important method of treatment had been exhausted by the two distinguished surgeons, Knapp of New York and Jackson of Denver, whose patient he had been. At the suggestion of Dr. Schneideman of Philadelphia, and with the added recommendation of Knapp and Jackson, *x*-ray treatment was begun in June, 1904. During all treatments the eyes were open, there were no signs of dermatitis, the lashes and brows were not the least affected by treatment. Patient is perfectly well. He insists on exposing both eyes to the rays once a month for five minutes, which Kassabian regards as unnecessary, considering the cure complete.

In the language of Kassabian, the technic is as follows:

Induction coil (15-inch spark producing) energized with 110-volt current, mechanical interrupter 2 amperes going to primary coil. Crookes' tube with "medium vacuum" anode being at a distance of 12 to 15 inches (30 to 38 cm.). The face and chest were covered with a sheet of lead through one opening of which the patient looked towards the tube during exposure. Treatments were given for the first three consecutive months twice a week, the time of exposure being gradually increased from one to two minutes. On September 19, 1904, after twenty-four exposures, the condition was greatly improved; the conjunctiva had become pale on the eye that was treated. During October, November and December treatment was continued only once a week, exposure two and one-half minutes. Treatment was discontinued for two months (January and February, 1905) and begun again March 1, with an exposure of three minutes once a week. Blood vessels are very small and fine, conjunctiva pale and white. Regular treatment was continued three months longer.

### GLIOMA.

Hilgartner[33] gives a brief note of a most extraordinary result of Roentgen ray treatment in a case of double glioma in a child aged three and one-half years. The growth in the right eye largely filled the vitreous and could easily be seen in its incipiency in the left eye. Pain was severe. Eighty-four exposures were given. Right eye shrank to two-thirds of its natural size and the growth in left eye was entirely absorbed.

Pusey's[33] results have been sufficiently encouraging to warrant his urging the use of the rays after removal of glioma and sarcoma to prevent a recurrence.

Würdemann[6] reports one case of glioma beginning in retina and extending to orbit, maxillary antrum and nasal passages. Three exenterations of the orbit were performed. *X*-rays were finally used for one year with a result of hindrance of development and absolute prevention of pain.

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[33] Quoted by Pusey and Caldwell: "Therapeutics of Roentgen Ray," 609.

### GUMMATA.

Parker, F. C.[6] (Norristown) reports a most interesting case of bilateral gumma of the orbit in a child eight years of age. Diagnosis was confirmed by microscopic examination, specific and *x*-ray treatment were both instituted, and it was Parker's opinion, based on the course of the case and its final cure, that the Roentgen ray applications were of very positive value.

### SCLERITIS AND EPISCLERITIS.

Pardo[22] in his long and interesting communication believes the results of *x*-ray in scleritis and episcleritis represent a real discovery inasmuch as at present there is no other direct therapeutic agent but only means amounting to a purely symptomatic treatment.

### CORNEAL ULCERS.

Dennett[34] reports having observed that ulcers of the cornea are stimulated to rapid healing by the rays. Williams[34] reports a case of flat leucoma in the lower half of cornea. Exposures were given once a week for three months, then twice a week for two months, after which the scar was smaller, smoother, and less dense and vision improved.

### UVEITIS.

Jackson[6] (Denver) is utilizing the rays in traumatic uveitis. Several times they have given immediate relief from pain and seemed to bring about rapid improvement. In other forms of uveitis he has not seen any marked effect from it.

### TUBERCULOSIS OF CONJUNCTIVA.

Sidney Stevenson[35] reports the following case:

A poorly nourished, pallid child, aged 4, was placed under treatment November, 1902. Trachoma-like material was found in semilunar fold. Lid was half closed and thickened

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[34] Quoted by Allen: "Radiotherapy in Ophthalmology,"

[35] Stevenson: "Tuberculosis of Conjunctiva," Boston Med. Jour., 1903, p. 1313.

**lower palpebral conjunctiva was strewn with miliary granulations and folds of coxcomb like tissue. Similar changes were in the superior retrotarsal fold. Tubercular bacilli were found locally. There were positive results from inoculation experiment. Thirteen *x*-ray exposures of ten minutes resulted in complete cure of the conjunctival disease. Enlarged submaxillary glands were present and were removed by operation.**

### CAUTION IN USE OF THE RAYS.

It is important that a note of warning should be sounded regarding the possibility of unlooked for results of a serious character which are said by competent observers occasionally to follow *x*-ray exposures. They would seem to indicate the very great importance of referring our cases to none but experts in Roentgen therapy. I have seen several cases of temporary corneal haze, conjunctivitis and marked episcleral congestion, but all such conditions subsided with the cessation in the use of the rays.

Dr. Henry K. Pancoast, chief of the *x*-ray department of the University of Pennsylvania, warns us regarding the possibility of the induction of severe conjunctivitis, ulceration and opacity of the cornea, edema of the conjunctiva and lids and optic neuritis. If the growth overlies the eyeball a hard rubber, ivory or metal eye spatula may be inserted under the lids.

In one of Sweet's cases of rodent ulcer the application of the rays was followed by the dulling of the mental faculties the following day. Wild reports a case of epithelioma in which the *x*-ray treatment was followed by the development of panophthalmitis, necessitating the removal of the globe. This must be regarded as a result so exceptional as to be unique.

Birch-Hirschfeld believes the rays capable of leading to very serious results if not skillfully applied. In his experiments on rabbits he believes he has certain proof of the existence of blepharitis with loss of hair and eyelashes, conjunctivitis keratitis profunda, and iritis. Some cases showed evidence of optic atrophy. The microscope in certain instances revealed degeneration of the ganglionic layer of the retina. In four clinical cases, marginal keratitis with vascularity was noted. These serious changes would seem to be the outcome of too lengthy exposures to the action of the rays. Indeed, Pusey of Chicago in one of his excellent early papers remarks on the possibility of producing atrophy of such highly differentiated epithelial structures as the retinal rods and cones, and regards the production of an inflammation of the conjunctiva as quite as likely as that of the skin structure. Hallopeau and Godaud[34] found the patient experienced a disagreeable impression of bright light after long exposure.

Subcutaneous extravasations of blood are said to have resulted in several instances, and Ehrmann quoted by Charles S. Bull described a telangiectatic appearance as a late result of *x*-ray exposure. A few cases of sarcoma and carcinoma by Burdick, Butler, Culey, Edwards and Pusey have been reported in which exacerbations of pain occurred as the result of the exposures.

## CONCLUSIONS.

1. *X*-ray therapy marks a great advance in the treatment of superficial epithelioma and rodent ulcer of the eyelids and can usually be relied on to effect a cure.
2. If unsuccessful then electro-chemical sterilization may be utilized, or finally excision with or without plastic operation.
3. *X*-ray treatment has proven of value in the more extensive orbital carcinomata, but it is conceded that the deeper the growth the less favorable will be the result.
4. A sufficient number of cures of sarcoma of lids and orbit have been reported to warrant its exhaustive trial in all types of this disease. More radical operative procedures with subsequent ray applications being indicated in event of primary failure.
5. *X*-ray treatments usually exert an anodyn influence on malignant disease of the eyelids and orbit, but are occasionally reported to cause exacerbations of pain.
6. Noteworthy progress in the treatment of trachoma has been effected by the utilization of *x*-ray therapy. It should invariably be utilized if ordinary methods fail.
7. The weight of evidence indicates the positive value of *x*-ray treatment of vernal conjunctivitis.
8. There is evidence which points to the value of *x*-ray therapy in chronic conjunctivitis (Kassabian), scleritis, episcleritis (Pardo), traumatic uveitis (Jackson), conjunctival tuberculosis (Stevenson); corneal ulceration (Dennett), glioma (Hilgartner and Würdemann) and gummata (Parker).

9. It is believed that the rays will cure malignant disease involving the cornea and conjunctiva, provided treatment is applied sufficiently early.

10. The treatment of congenital nevi by the rays is likely to prove effective and should be exhausted before electrolysis or radical operation is considered.

11. Further testimony must be accumulated before an authoritative statement is possible of the effect of *x*-rays in painful types of iridocyclitis and glaucoma and other ocular diseases.

CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# OCULAR INJURIES FROM FOREIGN BODIES,

## WITH REPORT OF 420 CASES.*

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PHILADELPHIA.

In the following paper are recorded the results of a study of 318 cases of ocular injury from foreign bodies in which Roentgen ray examination was made, the report supplementing a previous study made in 1901 of 102 similar cases. A tabulated statement of the 420 cases is given below.

For purposes of study the vitreous chamber is divided into three sections, the region of the equator including that portion 3mm. in front of, and 3mm. back of, the equatorial diameter; the ciliary region that portion in front of, and the posterior region, that portion back of, the outlined zone of the equator.

| Position of body. | First series. | Present series. |
|---|---|---|
| In the eyelid | 1 | 2 |
| In the lens | 3 | 14 |
| In iris, or posterior chamber | 1 | 4 |
| In the ciliary region | 24 | 27 |
| Near the equator | 21 | 69 |
| Posterior part of eyeball | 12 | 46 |
| In the orbit | 3 | 11 |
| No body found by *x*-rays | 37 | 145 |
| Total | 102 | 318 |

Of the total number of injuries, 356 were caused by particles of iron and steel, 23 by copper, 25 by bullets or small shot, and 16 by glass, stone or coal. In 17 cases the body was situated in the eyelid or orbit, in none of which did the eyeball on the corresponding side escape injury. In one the injury to the lid was complicated by an incised wound of the cornea, prolapse of the iris, and traumatic cataract, all of which must have been made by a second body which did not lodge in the eyeball, or by a blow from one of the workman's tools.

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*This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

The right eye was injured in 178 cases and the left eye in 242 cases. The relatively greater frequency of injury of the left eye is probably due to the position taken by right-handed workmen in handling their tools and in chipping or hammering metal.

The majority of patients were referred to me for *x*-ray localization from the Wills Hospital, the Jefferson Hospital, the University Hospital and the Pennsylvania Hospital, and I am under obligations to the surgeons connected with these institutions who operated on the cases for assistance in recording the ultimate result in each case. Many of the patients have remained under observation since operation. Some have returned periodically for examination, others have been visited at their place of business or at their homes, so that the present condition of their eyes has been determined. In others it has been impossible to learn the late result because of removal from their previous homes, and adoption of other methods of livelihood.

In the first series of cases, which includes injuries seen from 1897 to 1901, there were 65 cases in which a foreign body was located in the eyeball or surrounding tissues. Since this published report, three eyeballs were removed, two for iridocyclitis a few months later, and one because of recurring hemorrhage into the interior of the eyeball four years after extraction of the steel. The ultimate result in these 65 cases, so far as data could be obtained, together with the results in the 318 cases of the present series, is as follows:

| EYEBALLS ENUCLEATED: | First series. | Present series. |
|---|---|---|
| Extraction not attempted or failed | 14 | 19 |
| Extraction successful; enucleated later | 8 | 26 |
| EYEBALLS NOT ENUCLEATED: | | |
| No operation attempted | 7 | 13 |
| Bodies in the orbit or eyelid | 4 | 9 |
| Extraction failed | 2 | 6 |
| EXTRACTION SUCCESSFUL: | | |
| Vision, between 6/6 and 6/12 | 7 | 20 |
| Vision, between 6/15 and 6/60 | 4 | 13 |
| Fingers or hand movements | 0 | 7 |
| Good light projection | 9 | 27 |
| Light perception | 6 | 21 |
| No light perception, eye normal size | 0 | 6 |
| Eyeball shrunken | 4 | 6 |
| No bodies shown by the *x*-rays | 37 | 145 |
| Total | 102 | 318 |

The first series of cases covers a period during which the small Hirschberg magnet, operated by fluid batteries, was practically the only instrument available, and insertion of the magnet point into the vitreous was necessary in nearly every case. Notwithstanding the added traumatism of the magnet, the visual acuity in these cases has been retained up to the present time.

In the present series of cases, magnets with greater attractive power have been used, and, although a few of the surgeons have adhered to the method of introducing an elongated tip into the vitreous, most of the operators apply the large, short tip of the magnet at the wound of entrance or at an incision made in the sclera, only entering the smaller point when the magnet at the scleral opening fails to withdraw the body.

In a few instances the metal was removed by the Haab magnet, but in the majority of cases the Sweet magnet operated on the 110-volt lightning circuit was used. Bodies situated in the lens or in the posterior chamber were extracted by way of the anterior chamber, and this plan was followed in four of the bodies located in the vitreous chamber, but the operation of choice has been to withdraw the body through the wound of entrance when still open, or through a meridional incision in the sclera made close to the indicated position of the body, the point of selection being between the external and inferior recti muscles.

In most cases of recent injury the larger magnets have sufficient power to attract the metal without entering the point into the vitreous, and it is only when the body is embedded into the choroid or sclera that insertion of the magnet becomes necessary. It is true that good vision has resulted in spite of the entrance of the magnet point deeply into the vitreous, but experience has demonstrated that this procedure increases the traumatism and contributes to ultimate shrinking of the ball or to iridocyclitis.

Cases not seen until weeks or months after injury must be dealt with according to the site of the metal and the symptoms from which the patient suffers. The *x*-ray localization will often assist the operator in judging of the possible difficulty in removing the metal. Bodies situated above the horizontal plane of the globe or posteriorly in the vitreous chamber are usually caught in the coats of the eye, and in a few days or weeks become firmly bound by inflammatory exudation which resists extraction even with the magnet point brought close to the indicated location. Bodies at the bottom of the vitreous, in the neighborhood of the ciliary body or equator, usually drop into this region after penetrating the anterior segment of the globe, and, not having penetrated the retina or choroid, are more readily secured, even after remaining in the eyeball for a considerable period.

In old cases that will presumably offer difficulties in the extraction of the metal, operative interference may be postponed so long as the eye is quiet. The patient, however, must understand the necessity of promptly seeking advice should inflammatory symptoms arise. If the injured eyeball is irritable, or sympathetic irritation exists, an attempt should be made at once to extract the metal, and in the event of failure the ball should be enucleated without delay.

## EYEBALLS SAVED.

In the first series of cases, extraction was successful and the eyeballs were save in 30 cases, 7 with vision better than 6/12, 4 between 6/15 and 6/60; 9 with good light projection; 6 with light perception, and 4 with slightly shrunken eyeballs. In the present series, extraction was successful in 100 cases, with vision better than 6/12 in 20, between 6/15 and 6/60 in 13, counting fingers or hand movements in 7, good light projection in 27, light perception in 21, no light perception in 6, and eyeballs shrunken in 6. In the total 63 cases with light projection or light perception removal of the cataract would ensure serviceable vision in many of the patients.

A summary of the 106 cases of the present series is given in Table 1. The details of the first series of cases studied have been previously published,* and are therefore not given here.

An analysis of the visual results in the patients that have been under observation for a period of years, in which a scleral incision was made in the extraction of the metal, indicates that retinal detachment following this method of procedure must be of rare occurrence. In not one of the cases in the tabular statement in which the media permit a study of the region of the incision made in the ocular structures has detachment of the retina occurred, although in many of the patients a sufficient period has elapsed to exclude further retinal or choroidal changes. The continued irritation

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* Transactions American Oph. Society, 1901.

## TABLE 1.—EYEBALLS SAVED.

| Case. | Surgeon. | Period Between Injury and Operation. | Period Between Operation and Last Examination. | Vision. | Remarks. |
|---|---|---|---|---|---|
| 111 | Love | 1 day. | 1 mo. | Good proj. | Cataract. |
| 118 | Schwenk | 7 days | 4 yr. | 6/9 | " |
| 162 | Ziegler | 3 days | 1 " | No l. p. | Ball shrunken. |
| 182 | de Schweinitz | 8 mo. | 2 mo. | 6/6 | Aphakia. |
| 260 | Zentmayer | 7 wk. | 2 " | 6/9 | " |
| 337 | Sweet | 15 yr. | 1 yr. | Good proj. | Cataract. |
| 368 | Sweet | 1 day. | 2 mo. | " " | Cap. cataract. |
| 386 | Hansell | 1 day. | 4 " | 6/60 | " " |
| 388 | Posey | 1 day. | 1 " | Good proj. | Cataract. |
| **POSTERIOR CHAMBER:** | | | | | |
| 159 | Risley | 4 wk. | 3 mo. | 6/9 | |
| 166 | Posey | 8 " | 3 " | 5/25 | |
| 227 | Van Pelt | 2 " | 2 yr. | Good proj | Cataract. |
| 195 | Harlan | 4 days | 3 " | 6/9 | |
| **CILIARY REGION:** | | | | | |
| 119 | Risley | 2 days | 4 yr. | Good proj. | Cap. cataract. |
| 125 | Oliver | 35 " | 2 mo. | 5/10 | |
| 126 | McClure | 3 " | 4 yr. | No l. p. | Eye slightly shrunk'n. |
| 185 | Thomson | 7 yr. | 3 mo. | No l. p. | " " " |
| 151 | Radcliffe | 2 " | 4 yr. | No l. p. | Eye normal size. |
| 167 | de Schweinitz | 2 mo. | 4 mo. | 6/5 | |
| 217 | Thomson | 10 days | 5 " | Good proj. | Cataract. |
| 223 | McClure | 3 " | 1 " | L. p. | " |
| 248 | Oliver | 5 " | 2 yr. | Fingers 9'. | " |
| 255 | Sweet | 1 day. | 2 " | 6/9 | Aphakia. |
| 257 | Hansell | 15 mo. | 2 " | No l. p. | Eye normal size. |
| 261 | Ziegler | 3 days | 2 " | Fingers 3'. | Cataract |
| 268 | Ziegler | 5 mo. | 18 mo. | Good proj. | " |
| 285 | Sweet | 3 hr. | 2 yr. | 6/6 | |
| 300 | McClure | 2 days | 5 mo. | 6/22 | |
| 326 | Posey | 2 " | 1 " | 6/9 | |
| 334 | Ziegler | 8 yr. | | | Opt. ciliary neurect.<br>Extraction failed |
| 365 | Oliver | 6 mo. | 6 mo. | Imp. l. p. | Eye shrunken bef. ex. |
| 369 | McClure | 18 " | 4 " | No l. p. | Eye slightly shrunk'n. |
| 370 | Risley | 3 wk. | 3 " | Good proj. | Capsular cataract. |
| 398 | Oliver | 8 days | 1 " | 6/9 | |
| **EQUATOR:** | | | | | |
| 107 | Schwenk | 13 days | 5 yr. | No l. p. | Eye slightly shrunk'n. |
| 117 | Oliver | 13 " | | 5/20 | Extraction failed |
| 120 | Ellegood | 7 " | 7 wk. | 6/60 | |
| 139 | Sweet | 7 " | 2 yr. | Fingers 5'. | Part. ret. detach. |
| 141 | Ellegood | 4 " | 1 mo. | Fingers 3'. | Cap. cataract. |
| 145 | Posey | 1 " | 6 " | 6/22 | Part. ret. detach. |
| 152 | McClure | 7 " | 3 " | Good proj. | Aphakia. |
| 155 | Murdock | 3 " | 1 " | " " | Cataract. |
| 157 | de Schweinitz | 2 hr. | 1 " | 6/6 | " |
| 163 | Sweet | 9 mo. | 3 yr. | 6/6 | |
| 165 | de Schweinitz | 5 wk. | 1 mo. | Fingers | Body loose in vit. |
| 168 | Oliver | 6 days | 3 yr. | 6/30 | Large ret. det. bef. ex. |
| 171 | McClure | 1 wk. | 6 wk. | L. p. | Cap. opacities. |
| 176 | de Schweinitz | 6 mo. | 3 yr. | Fingers 2'. | |
| 178 | Fisher | 2 days | 2 " | L. p. | Chor. degeneration. |
| 179 | Randolph | 2 wk. | 3 " | Good proj. | |
| 183 | Harlan | 4 days | 3 " | 6/6 partly. | |

## TABLE 1.—EYEBALLS SAVED (Continued).

| Case. | Surgeon. | Period Between Injury and Operation. | Period Between Operation and Last Examination. | Vision. | Remarks. |
|---|---|---|---|---|---|
| 185 | Harlan | 1 “ | 6 mo. | L. p. | Pupil occluded. |
| 193 | Harlan | 3 “ | 1 wk. | Good proj. | Cataract. |
| 198 | Parker | 2 “ | 3 yr. | 5/9. | Isol. opac. of lens. |
| 205 | Radcliffe | 1 mo. | 1 “ | Good proj. | Cataract. |
| 210 | McClure | 1 “ |  |  | Extraction failed |
| 215 | de Schweinitz | 3 “ | 2 days | L. p. | Cataract. |
| 228 | Risley | 5 days | 1 mo. | H’nd move |  |
| 229 | Sweet | 2 “ | 4 “ | L. p. |  |
| 232 | McClure | 3 “ | 3 yr. | 6/60. | Cap. opacities. |
| 241 | Fisher | 3 “ | 2 “ | Good proj. | Cataract. |
| 244 | McClure | 2 “ | 2 “ | “ “ | “ |
| 251 | Hansell | 3 mo. | 3 mo. | “ “ | “ |
| 258 | Oliver | 2 days | 2 yr. | No l. p. | Eye slightly shrunk’n. |
| 265 | Oliver | 2 wk. | 2 mo. | 5/20. |  |
| 267 | Risley | 3 “ |  |  | Extraction failed |
| 270 | Risley | 6 “ | 1 mo. | L. p. | Eye slightly shrunk’n. |
| 278 | Sweet | 6 “ | 1 yr. | 5/20. | Cap. opacity. |
| 302 | Schwenk | 3 days | 1 “ | Good proj. | Cataract. |
| 304 | Ziegler | 7 mo. | 18 mo. | L. p. | Ret. dt. bef. oper. |
| 306 | Schwenk | 2 days | 1 yr. | 6/15. |  |
| 309 | Sweet | 1 mo. | 3 mo. | Imp. l. p. | “ “ “ “ |
| 319 | Radcliffe | 4 days | 14 “ | 6/6. | Aphakia. |
| 339 | Fisher | 12 “ | 1 yr. | 6/30. | “ |
| 348 | Fisher | 1 “ | 1 mo. | 6/9. |  |
| 351 | Risley | 6 “ | 1 “ | Good proj. | Cataract. |
| 361 | Sweet | 4 “ | 1 yr. | “ “ | “ |
| 382 | McClure | 4 “ | 4 mo. | 6/15. | Cap. opacity. |
| 385 | Sweet | 21 yr. | 6 “ | No l. p. | Eye normal size. |
| 387 | Ziegler | 4 days |  |  | Extraction failed |
| 394 | Fisher | 2 “ | 2 “ | L. p. | Eyeball irritable. |
| 391 | Ziegler | 9 yr. | 3 mo. | No l. p. | Eye normal size. |
| 414 | Sweet | 2 days | 1 “ | Imp. l. p. | Vitreous opac. |
|  | POSTERIOR PART OF GLOBE: |  |  |  |  |
| 116 | Zentmayer | 3 days | 1 mo. | Good proj. | Cataract. |
| 121 | Risley | 7 “ | 2 “ | “ “ | Part. cataract. |
| 122 | Thomson | 2 “ | 4 yr. | 6/6. |  |
| 128 | Schwenk | 3 mo. | 4 “ | Imp. l. p. | Part. ret. detach. |
| 134 | McClure | 15 days | 2 mo. | L. p. | Vitreous opacities. |
| 233 | Zentmayer | 1 “ | 3 yr. | L. p. | Cataract. |
| 237 | Risley | 2 wk. | 3 “ | 6/12. |  |
| 239 | Oliver | 4 days |  |  | Extraction failed. |
| 245 | McClure | 4 “ | 3 mo. | L. p. | Cataract. |
| 252 | Posey | 2 “ | 1 “ | L. p. |  |
| 254 | Posey | 2 wk. | 2 “ | L. p. |  |
| 295 | Risley | 1 “ | 2 “ | Good proj. | Cataract. |
| 305 | Harlan | 1 mo. | 3 “ | No l. p. | Normal size eye. |
| 310 | Sweet | 6 days | 2 “ | Imp. l. p. | Cataract. |
| 317 | Ziegler | 2 mo. | 2 “ |  |  |
| 318 | Sweet | 13 days | 1 yr. | Good proj. | “ |
| 336 | Schwenk | 12 “ | 1 mo. | “ “ | “ |
| 375 | McClure | 2 “ | 2 “ | 6/60. | Vitreous opacities. |
| 348 | Fisher | 1 “ | 1 “ | 5/9. |  |
| 351 | Risley | 6 “ | 3 “ | L. p. | Cataract. |
| 379 | Posey | 10 mo. | 5 “ | Good proj. | “ |
| 393 | Van Pelt | 2 “ | 3 “ | “ “ | “ |
| 407 | Oliver | 5 “ | 1 “ | No l. p. | Degener. vitreous. |

and exudative inflammation of a long retained foreign body in the coats of the eye is probably a more potent factor in causing detachment of the retina than a small, clean cut of the sclera and the adjacent retina and choroid.

In several of the tabulated cases retinal detachment was present prior to extraction of the metal, and in many eyeballs with only light perception the retina is likewise detached, but it is difficult to say whether the presence of the foreign body or the insertion of the magnet point in the removal of the body was the primary cause of the detachment.

### EYEBALLS LOST.

In the first series of cases, 22 eyeballs were lost, in 7 of which the injury was by non-magnetic bodies. In 9 cases extraction was not attempted; 3 cases were injuries from steel, and 6 from copper or small shot. In 5 cases extraction failed, and on enucleation, the metal in the eyeball was found firmly embedded in new fibrous tissue. In 8 cases the body was successfully removed, but enucleation was required in 5 cases because of iridocyclitis, in 2 cases from recurring hemorrhages into the vitreous, and one from panophthalmitis.

In the present series, 45 eyeballs were lost, in 35 of which the injury was from iron or steel, 6 from shot and 4 from copper. In 12 cases no attempt was made to extract the metal; in 7 cases extraction failed, while in 26 the body was successfully removed. In 8, evidences of panophthalmitis was present at the time of examination, and in 2 the ball was immediately removed, in 5 on the following day, and in 1 on the ninth day; in the other 18, the magnet point was inserted into the vitreous in nearly every instance, increasing thereby the traumatism, and probably in a large measure contributing to the iridocyclitis that compelled ultimate enucleation. In a number of these cases the body had remained in the eyeball a sufficient time to render the saving of the globe problematical, even in the event of successful extraction. The period between injury and operation in the 18 cases was three days in 3 cases; four days in 1; five days in 2; seven days in 1; fourteen days in 1; sixteen days in 1; twenty-four days in 1; four weeks in 2; five weeks in 2; and the remaining 4 cases, six months, eight months, eighteen months and thirteen years, respectively.

A further cause contributing to the loss of the eyeball in a number of the cases was the severe traumatism at the time of injury, the large size of the metal almost immediately destroying the usefulness of the eye. The dimensions of the body in nine cases were as follows: Case 113, 5x4 mm.; case 153, 8x5 mm.; case 154, 12x6 mm.;

TABLE 2.—EYEBALLS LOST.

| Case. | Time Between Injury and Operation. | Time Between Extraction and Enucleation. | Cause of Loss of Eye. | Size of Body in mm. |
|---|---|---|---|---|
| | LENS: | | | |
| 115 | 1 days, | 1 day | Panophthalmitis. | 3 x 1 |
| | CILIARY REGION: | | | |
| 146 | 3 days | 5 months | Iridocyclitis | 1 5 x 1 |
| 153 | 7 “ | 1 month | “ “ | 8 x 5 |
| 235 | 6 months. | 3 months | Rec. hem. ant. chamb. | 4 x 2 |
| 312* | 2 days | Ext. failed | Sympathet. irritation | 7 x 2 |
| 313 | 16 “ | 1 month | Iridocyclitis | 10 x 7 |
| | EQUATOR: | | | |
| 130 | 2 weeks. | 23 days | Iridocyclitis | 6 x 4 |
| 154 | 5 “ | 1 month | Shrunken and tender. | 12 x 6 |
| 160 | 5 days | 4 months | Iridocyclitis | 3 x 1 |
| 173 | 4 weeks. | 6 weeks | “ “ | 4 x 1 |
| 184 | 8 months. | 1 month | “ “ | 3 x 2 |
| 186† | 3 “ | Ext. not tried. | Shrunken and tender. | |
| 187† | 1 month | “ “ “ | Sympathet. irritation | |
| 234 | 10 days | Same day | Panophthalmitis. | 5 x 1 |
| 240 | 1 day. | “ “ | “ “ | 3 x 4 |
| 272 | 13 years. | 3 weeks | Iridocyclitis | 3 x 1 |
| 298 | 1 week | Ext not tried | “ “ | 7 x 3 |
| 315 | 1 week | “ “ “ | “ “ | 4 x 2 |
| 333 | 1 day | 1 day | Panophthalmitis. | 3 x 2 |
| 402 | 1 “ | Ext. not tried. | “ “ | 1 x 0.5 |
| 415† | 9 days | “ “ “ | Iridocyclitis | |
| | POSTERIOR: | | | |
| 109 | 2 months. | Ext. failed | Iridocyclitis | 1 x ¼ |
| 113 | 3 weeks. | “ “ | “ “ 4 yr. later | 5 x 4 |
| 131 | 3 days | Same day | Panophthalmitis. | 4 x 2 |
| 158 | 2 weeks. | Ext. failed | Iridocyclitis | 2 x 1 |
| 161 | 5 “ | 1 month | Shrunken and tender. | 13 x 6 |
| 185 | 3 days | 6 months | Iridocyclitis | 6 x 2 |
| 197† | 2 “ | Ext. not tried. | “ “ | |
| 200 | 4 “ | 2 months | “ “ | 4 x 2 |
| 207 | 3 “ | 1 day | Panophthalmitis. | 14 x 1 |
| 211 | 4 weeks. | 1 year | Iridocyclitis | 3 x 2 |
| 230* | 3 “ | Ext. not tried. | “ “ | 4 x 2 |
| 277 | 6 months. | Ext. failed | “ “ | 3 x 2 |
| 279 | 18 “ | 6 months | Shrunken and tender. | 3 x 1 |
| 296 | 3 days | Same day | Panophthalmitis. | 4 x 1 |
| 331 | 5 “ | 21 days | Iridocyclitis | 4 x 2 |
| 322 | 4 “ | 3 “ | Panophthalmitis. | 5 x 1 |
| 396† | 5 weeks. | Ext. not tried. | Severe migraine | |
| 401 | 2 months. | “ “ “ | Iridocyclitis | 3 x 1 |
| 406 | 3 days | 9 days | “ “ | 12 x 9 |
| 364 | 24 days | 4 weeks | “ “ | 9 x 2 |
| | ORBIT: | | | |
| 288* | 2 days | Ext. failed | Iridocyclitis | 4 x 2 |
| 297 | 7 “ | “ “ | “ “ | 2 x 1 |
| 308† | 2 “ | Ext. not tried. | Sympathet. irritation | |
| 352* | 8 “ | “ “ “ | Iridocyclitis | 1 x 0.5 |

* Copper. † Shot.

case 207, 14x1 mm.; case 298, 7x3 mm.; case 313, 10x7 mm.; case 364, 9x2 mm.; and case 406, 12x9 mm.

The summary of the 45 cases in which enucleation was required is given in Table 2.

The comparatively few cases of panophthalmitis, indicate the resisting power of the vitreous to infection. To some extent disinfection of the body may occur as it passes through the coats of the eye into the interior. Even if the instances of late iridocyclitis are considered as types of infection, the percentage of loss from this cause is small in comparison with the large number of cases of injury. Two causes act to produce loss of the ball from iridocyclitis, the formation of a fibrinous exudate about the foreign body that complicates the extraction by the insertion of the point of the magnet once or more into the vitreous, or the original traumatism is so severe that the eye can not recover.

### NO BODIES IN THE EYEBALL.

An unusual large proportion of the total number of injuries was shown by the radiographs to have no foreign body in the eyeball or orbit. In each, the diagnosis of the presence of a foreign substance within the ball was probable from the character of the work on which the individual was engaged, the nature of the injury, and the condition of the eyeball or the reduction in vision.

Of the 145 cases embraced in the present series, 30 were seen within 24 hours of injury, 32 between the second and fourth days, 42 between the fifth day and the end of the second week, 27 between one month and nine months, and 14 over one year. In 49 cases cataract existed, 28 in patients examined during the first week after the injury and 21 after this period; in 5 cases hemorrhage into the anterior chamber was associated with a wound of the cornea or limbus; in 8 cases extensive posterior synechia was present, with opacities on the anterior lens capsule; in 13 recent injuries there was hemorrhage or opacities in the vitreous; while in 20 cases of old injury vitreous opacities prevented a view of the eyeground.

Of the total number of injured eyes showing no foreign body, 124 were caused by iron and steel. 10 by copper from premature mining explosions, 7 by glass or stone, and 4 by small shot.

## ORBITAL CASES AND CASES UPON WHICH NO OPERATION WAS MADE.

In 20 cases of ocular injury in which the radiographs showed the presence of a foreign body in the eyeball or surrounding structures, no operation on the eyeball was performed, and so far as could be learned, none of these eyes has been removed. Cases in which no operation was performed, but the eyeball enucleated, are included in another part of this report. Of the 20 cases, 4 were foreign bodies in the lens, two of steel and one of copper; 8 were in the vitreous, six of steel and two of small shot; and 8 were in the orbit, three bullets or small shot, four steel, and one stone. In three patients the eyeballs were shrunken and enucleation was advised, but refused.

There is a more general recognition on the part of the attending physicians who are usually first consulted in these ocular injuries from foreign bodies, of the importance of an early diagnosis. A higher percentage of successful extraction, with preservation of vision, would be secured if every case of ocular injury with reduction of visual acuity was subjected to the *x*-ray examination within a few hours after injury, and the foreign body immediately extracted, should one be shown to have penetrated into the eyeball. Such a course would most largely contribute to the saving of the eyeball and the preservation of some sight, although with the same methods of operation, the same precautions in surgical technic and the same promptness in diagnosis and in extraction, the result in one case may be a shrunken, tender eyeball, that must ultimately be removed, while in another case full acuity of vision will be secured.

## SUMMARY.

Total number of injuries from foreign bodies. 420; foreign bodies located in the eyeball, 221; in the orbit, 14; in the eyelid, 3; no bodies shown by the Roentgen rays, 182. Injuries by iron and steel numbered 356; copper, 23; bullets or small shot, 25; and glass, stone, or coal, 16.

Of the 221 cases in which the foreign body was located in the eyeball, extraction succeeded in 164, failed in 18 and was not attempted in 39. The number of eyeballs lost was 67; in 4 of the injuries the foreign body was in the orbit. Of the 63 cases in which the body was in the eyeball, extraction was not tried in 19, failed in 10 and succeeded in 34. In 9 of the successful extraction evidence of beginning panophthalmitis existed at the time of the first examination, while many of the others were old injuries, in which the body was only secured after numerous insertions of the magnet into the vitreous.

The results of operation on the eyeballs containing foreign bodies were: Vision better than 6/12 in 27; between 6/15 and 6/60 in 17; counting fingers or recognition of hand movements, 7; light projection, 36, and light perception 27, with a certainty of increased vision in many of these cases on the removal of the cataract; no light perception, but eyeball of normal size, 6; shrunken eyeball, 10.

### CONCLUSIONS.

1. Radiographic examination should be made in every case of ocular injury from a foreign body in which lowered visual acuity is a result of the accident.
2. Extraction of a foreign body through a small meridional incision in the sclera, the magnet point not introduced into the vitreous, causes no greater traumatism than follows drawing the metal through the vitreous into the anterior chamber.
3. Retinal detachment is not a logical result of a scleral incision for the extraction of a body from the vitreous chamber. The exudation associated with a long-retained foreign body is probably a more frequent cause of detachment.
4. Introduction of the magnet point into the vitreous increases the traumatism to the eyeball, encourages retinal detachment and often leads to shrinking of the eyeball and to iridocyclitis.
5. Bodies located above the horizontal plane of the globe or at the posterior part of the vitreous chamber usually present greater difficulties in extraction, owing to the early formation of a fibrous exudate around the imbedded metal, than bodies at the bottom of the vitreous near the equator, to which position they fall after penetration.

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# AUTOINTOXICATION IN RELATION TO THE EYE.*

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## INTRODUCTION.

Observers differ, often widely, in their conception of autointoxication; hence it is necessary first to describe, briefly at least, what is included in the term in so far as the present contribution is concerned.

As W. Louis Chapman[1] points out, "the variety of definitions given for this state bears testimony to the difficulty of obtaining one which is terse yet comprehensive." The one advocated by Albu[2] is as follows: "Autointoxication is a poisoning of the organism by the products of its own metabolism, which may be normal, but accumulated in excessive quantities, or they may be abnormal. Among the latter it is necessary to distinguish between those which are subject to further transposition, and those which are formed not at all or only in slight degree in the healthy organism."

Food in its passage from the mouth to the large intestine is subject to complex chemical processes which include oxidation, reduction, decomposition and synthesis. The results are the end products of assimilation, water, inorganic salts, urea, uric acid, etc. Between the introduction into the mouth of nourishment and the appearance of these ultimate substances occurs the development of the intermediary products of metabolism, called by Gautier the leucomaines. Normally, they are oxidized, reduced, decomposed, or united with other substances in the body. Abnormally, if the outlet of metabolism meets with a check, they accumulate and are reabsorbed, and have been thought to hold etiologic relation to a number of disease-processes.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

[1] Chapman: "Autointoxication as a Cause and Complication of Disease," Fiske Fund Prize Essay, p. 9.

[2] Albu: "Ueber die Autointoxicationen des Intestinal Tractus," Berlin, 1895, p. 3.

The matter, however, does not end here. During the transposition processes which are going on in the human organism, there are produced not only useful and indifferent substances, but also injurious and poisonous products. Under normal conditions they create no evident disturbance, because they are formed only in very small quantities, or in marked attenuation; or they unite with other substances, or are rapidly expelled. Under abnormal conditions and in the presence of the failure in action of the inhibitory processes, the injurious and toxic action of the imperfectly oxidized products of metabolism is evident; in other words, autointoxication of the organism. Thus writes Albu, and it is from his introduction to this subject that the preceding statements have been quoted.

Let us see for a moment how the subject is approached by others. Von Jaksch[3] distinguishes (a) retention-toxicoses, with clinical (morbid) symptoms depending on the retention of physiologic bases; (b) noso-toxicoses, referable to the presence of basic products, which are formed in the organism (blood, etc.) in disease and eliminated with the urine; (c) autotoxicoses, with clinical symptoms which are caused by the formation of toxic basic substances from morbid materials, such as pathologic fluids present in the body, which bases are absorbed and give rise to manifestations of severe poisoning; and (d) exogenous toxicoses, with clinical symptoms or morbid entities due to toxic basic substances ingested with the food, such as the poison of sausages and cheese. Other authors, for example Albu, are unwilling to accept without modification von Jaksch's classification, or to agree with him and others; for instance, Kobert, Schwalbe and Bouchard, who count among the autointoxications all those diseases which arise from the action of a *contagium vivum*, that is, all the infections, or infectious diseases. Albu, also, and it would seem properly, wishes to strike from the list of autointoxications nutriment poisonings by flesh, sausage, cheese, mussels, etc., which Bouchard[4] includes. As Chapman[1] puts it: Specific infectious diseases must not be included with autointoxications; only substances which originate in, or are elaborated within, the system should be regarded as causing autointoxications. Thus, mussel or sausage poisoning is a different process from intestinal putrefaction in which poisonous diamins are formed within the bowel lumen. In other words, autointoxication must not be confounded with autoinfection.

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[3] Jaksch, R. von: "Clinical Diagnosis." Fifth English edition, edited by A. E. Garrod, 1905.

Although some authors would designate as autogenetic diseases only such as originate within the living cell itself and have gone so far as to regard the contents of the intestinal tract as being outside of the organism and, therefore, not participants in the condition under discussion, this ultra view is not accepted by the best authorities. It is true that putrefaction and decomposition of the intestinal contents are referable to the action of bacteria which have been introduced into it; but the autointoxications which arise from the poisonous substances thus produced differ from the infectious diseases caused by bacteria because the latter represent specific intoxications of the organism, while the former come into existence as the result of conditions which constantly obtain in the organism (Albu).

The classification adopted by Albu is as follows: (1) Autointoxication caused by loss of function of an organ, e. g., myxodema, pancreatic diabetes, Addison's disease, acute yellow atrophy of the liver; (2) autointoxication due to general abnormalities of metabolism, e. g., gout, oxaluria, etc.; (3) autointoxication from retention of physiologic products of metabolism in various organs of the body, e. g., toxic phenomena after extensive burns, carbonic acid poisoning in difficult respiration, uremia, etc.; (4) autointoxication caused by overproduction of physiologic and pathologic products of the organism, e. g., acetonuria, coma of diabetes, etc. In a position between groups three and four, and probably belonging to both, are the great majority of the autointoxications which proceed from the intestinal tract.

## AUTOINTOXICATION AND THE EYE.

Let us next briefly review this subject from the standpoint of those who are especially concerned with its relationship to the eye. Uhthoff[5] divides the autointoxications into: 1. Intestinal or enterogenous, (a) caused by affections of the digestive tract which lead to abnormal fermentation and decomposition processes; (b) caused by abnormal changes resulting from the presence of intestinal parasites (helminthiasis, etc.). 2. Histogenetic, (a) caused by the products of individual metabolisms (diabetes, gout, uremia, carcinoma, chlorosis, pregnancy, puerperium, lactation, etc.); (b) caused by insufficient elimination of the poisons of the body as the result of disease of certain organs (thyroid, adrenals, liver, hypophysis (?) ).

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[4] Bouchard: "Lectures on Autointoxication in Disease." Translated by Thomas Oliver, 1905, p. 159.

Elschnig,[6] the most recent systematic writer on the subject from the ocular standpoint, after reciting the classifications of von Jaksch and Uhthoff, already quoted, points out that thus far diseases of the eye of probable autogenetic origin have almost exclusively been brought into association with the affections which belong to the histogenetic autointoxications. The intestinal autointoxications have received little notice either in general ophthalmic literature or in ophthalmic text-books, and he, therefore, records the results of his study of such diseases of the eye which have come under his observation and which may have etiologic relationship to this variety of autointoxication. In order to make clear his viewpoint, he quotes Weintrand's[7] definition: "Gastrointestinal intoxications in the most restricted sense of the word are those conditions in which poisonous substances, foreign to the normal metabolism, are produced in the gastrointestinal canal by reason of abnormal fermentation, and are reabsorbed in such quantities that they call into existence pathologic phenomena. It is further to be understood that products of normal indigestion, if produced and reabsorbed in abnormal quantities, may also lead to autointoxication."

While it is admitted that certain diseases and certain symptoms are the result of autointoxication, in the present state of our knowledge it is not possible to indicate the exact nature of the toxic product which causes any autotoxemia, save one. In this connection it is interesting to quote from Alonzo Taylor:[8]

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[5] Graefe-Saemisch: "Handbuch der gesamten Augenheilkunde," second edition, 32-34, 1901, p. 179.

[6] Elschnig: Klin. Monats. f. Augen., vol. xliii, No. 2, 1905, p. 417.

[7] Weintrand: "Gastrointestinale Autointoxicationen," Lubarsch u Osterag, Ergebnisse, vol. iv, 1897.

> "We do not know the entity of a single autointoxication except the acidosis of diabetic coma. We do know that no known autointoxication is to be attributed to any known end product of any known metabolism. Bouchard's work on the toxicity of the urine is untrustworthy, and there is no measurable toxicity in the urine apart from that of the electrolytes. All our present knowledge rests on clinical analogy. When a nephritic suddenly becomes blind without a retinal lesion we say that he has a toxic blindness; until we have objective criteria of the assumed autointoxication we are limited to clinical analogies and these are naturally to be used with the greatest caution, since they are subject to no known objective control. Of course, antointoxications exist, probably in plenty, but of their true nature we know nothing."

For the sake of the discussion of the subject, we may divide ocular conditions to be considered from the standpoint of autointoxication into those which occur in connection with diseases which are believed to be the result of such a condition, and, in turn, to divide these into two sub-groups, that is to say, again quoting from Taylor: "Psychoses being excluded, any visual abnormalities that exist independent of structural lesions and conditions of probable autointoxication, such as uremia, diabetes, tetany, etc., might reasonably be termed symptoms of autointoxication." In the second group would appear such structural lesions in the eye that arise in connection with diseases of quite certain nature as autointoxication, namely, nephritis, diabetes and the essential anemias. With these we are familiar, although we do not know how the nephritis or diabetes or pernicious anemia causes the retinal alterations any more than we know how diabetes causes gangrene, how pernicious anemia creates spinal sclerosis or how nephritis originates endarteritis. With such phenomena of autointoxication the present communication is not concerned. We are, therefore, limited to the discussion of various ocular diseases, which, other etiologic factors being eliminated, seem, largely by reason of therapeutic tests and not from knowledge of any exact product, to be the result of an intestinal toxemia, or to be caused by an enterogenous decomposition product.

If we are to assume an autointoxication of gastro-intestinal origin as a probable etiologic factor in any ocular disease, it is necessary to know some sign by which such enterogenous decomposition may be recognized. The most definite symptom, as Elschnig points out, is the presence of abnormal organic compounds in the urine, for example, phenol and conjugate sulphates, substances which are difficult to test. Easier of recognition is indican, the presence of which in increased and persisting amounts in the urine indicates decomposition of albumin in the digestive tract. To be sure, it is present in fevers, in anemia, in leukemia and even in neurasthenia, but it is said not to be present during simple constipation. It is this presence of indican which Elschnig regards as the best test of disturbances in the alimentary canal and the production of products the reabsorption of which gives rise to the toxemia to which he attributes the influences that bring about various ocular conditions, and in his experience the corneoscleral region and the uvea are most likely to suffer.

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[8] Personal communication, Dec. 31, 1905.

## DISEASES OF THE OPTIC NERVE AND RETINA.

Referring to the possible relation of autointoxication to diseases of the optic nerve and retina, Uhthoff expresses the opinion that, while histogenetic autointoxication, with which the present paper is not concerned, may cause diseases of these tissues, intoxication of intestinal origin is almost entirely innocent of such etiologic relationship, although he is willing to admit that it may originate affections of the interior ocular muscles.

That retrobulbar neuritis may occasionally be the result of an intoxication which proceeds from the intestinal tract is indicated by Kraus' case, to which Elschnig[9] makes reference. A woman became suddenly blind, with all of the symptoms of retrobulbar neuritis. Eight days later she died, and autopsy failed to reveal any cause for death save gastrointestinal catarrh. The urine contained neither sugar nor albumin, but 25 per cent. of oxybutyric acid, and Kraus believes it probable that in this case an acid intoxication of intestinal origin was responsible for the symptoms and for the death of the patient.

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[9] Elschnig briefly recapitulates this case because, according to him, it appears to be unknown in ophthalmic literature. Edsall and I, however, have used this case in connection with our report of the examination of urine in cases of tobacco amblyopia. Trans. Amer. Ophth. Soc., 1903.

Of much more importance is the possible relationship of intestinal toxemias to the development of so-called toxic amblyopia, that is to say, to the ordinary tobacco-alcohol amblyopia. I discussed this subject some years ago,[10] and pointed out that it was quite possible that nicotin or one or more of the many principles freely present in tobacco smoke liberate some toxic influence in the system which must be held accountable for the disease, which, in other words, depend on a species of autointoxication. Long ago Horner contended that neither alcohol nor tobacco as such was the direct toxic agent in cases of central amblyopia, but that together these drugs produced chronic gastric catarrh, which, in its turn, established a chronic anemia of the optic nerve, terminating in the pathologic changes which are found in this disease. Sachs maintained that even in the pure tobacco cases certain complex chemical combinations occur in the stomach, and that there was a resulting transformation of the normal gastric juices into acids of the fatty type, which combined with nicotin into substances which were more injurious than the simple tobacco bases themselves. Förster and Groenouw have also referred to disturbances of appetite and inanition as factors in the production of this amblyopia, and Elschnig himself is able to confirm Sachs' statement of the constant presence of gastrointestinal disturbances in association with alcohol-tobacco amblyopia. So far as I know, only Edsall and I have thus, up to this time, tried to proved this suspected relationship to the amblyopia by an analysis of urine,[11] the results of which were reported to the American Ophthalmological Society in 1903. Seven cases of tobacco-alcohol amblyopia were carefully examined, with the following findings:

Case 1—High increase for conjugate sulphates, temporary intense indicanuria and slight urobilinuria. Case 2—Intense urobilinuria. Case 3—Moderate urobilinuria and high volatile fatty acids. Case 4—Moderate urobilinuria, marked indicanuria, decided reaction for phenol and high volatile fatty acids. Case 5—Intense indicanuria, moderate increase of conjugate sulphates, marked urobilinuria. Case 6—Intense urobilinuria and indicanuria and intense phenol reaction. Case 7—Marked

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10. Norris and Oliver: "System of Diseases of the Eye," vol. iv. p. 183.

11. de Schweinitz and Edsall: "Concerning a Possible Etiologic Factor in Tobacco-Alcohol Amblyopia, Revealed by an Analysis of the Urine of Cases of this Character."

reaction for phenol and notably high values for volatile fatty acids, with slight urobilinuria.

The results in general show that there was in all cases an excessive excretion of enterogenous decomposition products in the urine, and in all there was a more or less marked urobilinuria. In all the patients repeatedly examined these abnormalities nearly or quite disappeared under treatment, coincidentally with improvement in the eye conditions. A case of optic nerve atrophy examined as a control, the atrophy not being caused by tobacco and alcohol, showed almost entirely negative results, with only a slight reaction for indican and none for phenol. We stated that these facts gave just ground for the belief that toxic substances produced in the digestive tract, or in the course of metabolic processes, have at least a part in the production of amblyopia in these cases, and that at times they are probably the direct cause of the continuance of the symptoms when the latter do not appear after alcohol and tobacco have been stopped.

An amblyopia without ophthalmoscopic change in association with obstinate constipation has been attributed to an autointoxication proceeding from the intestinal tract by Young. Bulson[12] attributes the visual disturbances caused by excessive use of coffee (coffee amblyopia) to irritation of the digestive tract, created by this agent and consequent processes of decomposition and abnormal fermentation.

Elschnig refers to cases of scintillating scotoma and other neurasthenic symptoms which are seen in association with chronic intestinal catarrh and constipation, but very properly casts doubt on this etiologic factor, inasmuch as it is not proved that they may not be reflex manifestations from other sources, or from the intestines themselves, but not the indications of an absorbed poison.

## OCULAR MUSCLE ANOMALIES.

When all other causes for the presence of an exterior ocular muscle palsy have been excluded, it has been attributed at times to an autointoxication, but without any very definite examinations to justify the diagnosis. Paralyses of the interior ocular muscles are probably more likely the result of gastrointestinal intoxications, and their symptoms would not in any sense differ from those which are caused by ptomain poisoning, which, as we have already noted, is not to be reckoned among the autointoxications.

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[12] Bulson: Amer. Jour. of Ophth., vol. xxii, 1905, p. 55.

I have seen several cases of unexplained paresis of accommodation apparently follow the ingestion of pure foodstuffs, that is to say, the ingestion of food which was not in any sense tainted, and doubtless all of us can recall similar examples in our practice. Some years ago, before the ophthalmic section of the College of Physicians of Philadelphia, Dr. Charles Herman Thomas exhibited a young man who always an hour after food suffered from paresis of accommodation. The subsequent history of the case I do not know. In none of these cases, however, has accurate urinary analysis been made, and they, therefore, are only classified in this group because other etiologic factors were not evident. Elschnig records a more carefully examined case of cycloplegia and loss of the pupil light reflex in a patient whose urine showed marked indican reaction, and who had no other cause for this condition, and who promptly recovered under treatment directed to the digestive organs.

Elschnig refers to one case of ocular muscle palsy reported by Varese without greater detail, in which the condition was attributed to an intestinal intoxication as the result of helminthiasis. Such intoxications are classified by Uhthoff under the autointoxications, the second group of them, at least, but more properly, according to Elschnig, they should be brought into relationship with the noso-toxicoses of von Jaksch's classification.

## AFFECTIONS OF THE CORNEA AND SCLERA.

That a certain number of corneoscleral affections may possibly be referred to the action of toxins absorbed from the intestinal tract seems likely, the difficulty being, however, to eliminate other factors which are well established in their etiologic relation. A case in point is quoted by Elschnig of relapsing marginal ulceration of the cornea with increased indican reaction in the urine, and with cure which followed a careful diet and a regulation of habits tending to correct the abnormal intestinal fermentation. It certainly must be the experience of all ophthalmologists that regulation of the diet, intestinal antisepsis, and in general terms, what I may call gastrointestinal hygiene, is of the greatest moment in the treatment of relapsing corneal ulcers, especially in children and young adults, but that these corneal lesions should be designated as symptoms of the autointoxication is not by any means certain, although if persistent urine analysis persistently gave the indications of enterogenous decomposition and other factors were elimininated, such relationship would at least be probable.

Exactly the same remarks apply to various forms of scleritis, both of the deep and superficial variety and to that form which is known as the periodic fugacious episcleritis, the "hot eye" of the English writers. In these diseases the regulations of diet, etc., which have been referred to are of the greatest moment in treatment.

These types of scleritis and keratitis have recently been the subject of a brief communication by Frederick Groyer,[13] and he is satisfied, using the method of Obermayer for indican reaction, that its persistent presence in the urine with these diseases, especially if the other signs of abnormal intestinal fermentation are present, must be accepted as a sign that the exciting cause arises in the gastrointestinal tract.

### DISEASES OF THE UVEA.

The extreme difficulty of finding a satisfying cause for various types of uveitis, that is to say, uveitis with punctate keratitis, iridocyclitis, iridochoroiditis, recurring plastic choroiditis, and so-called relapsing or recurrent iritis, has led in recent times to a search for some toxin other than that supplied by syphilis and in vague terms by the rheumatic or lithemic diathesis.

According to Elschnig, what may be termed the gastrointestinal factor bears an important relation to these uveal tract diseases, and should be regarded in many of them, if not the sole, at least a contributing cause. Two varieties are in his experience particularly to be classified here.

1. Chronic iridocyclitis with deposits in the anterior chamber and opacities in the vitreous which occurs in women whose breath has an acetone-like odor and who are the subjects of gastrointestinal indigestions and who tend to be obstinately constipated. It is not necessary to burden the communication with many case histories, but the type is a familiar one. An excellent example recently under my care occurred in a woman aged about

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[13] Groyer: Muench. med. Wochft., Sept. 26, 1905.

20, of sedentary habits owing to her occupation, who appeared with a moderate episcleral flush, which rapidly developed, as is so often the case, into a sharp uveitis, with mutton-fat drops deposited on the posterior surface of the cornea, succeeded rapidly by a web-like exudate in the anterior chamber and flake-like opacities in the vitreous. Ordinary remedies were entirely insufficient, but cure came with startling rapidity after thorough intestinal antisepsis preceded by the free administration of calomel and regulation of habits and diet. In this case scientific urine examination was not made, therefore the exact amounts of indican cannot be given. It is used simply as a type of those varieties to which Elschnig makes special reference and which all of us must frequently have seen.

2. Elschnig's second variety is relapsing or recurrent iritis. He believes the subjects are ordinarily healthy individuals. An attack of iridocyclitis occurs, is recovered from, and the process repeated until, if the inflammation is not checked, blindness is likely to result. In his experience the ordinary antisyphilitic remedies are useless, while treatment of the digestive organs arrested the process in five out of seven of his cases. He gives the case histories of seven patients, and for details the original article should be consulted.

Again, a very important series of phenomena, postoperative in character, should be considered from the same standpoint, namely, postoperative delirium and postoperative iridocyclitis. As is well known, postoperative insanity, particularly after cataract extraction, has been ascribed to the use of the bandage, the effect of atropin, to exaggeration of an imperfect mental balance existing prior to operation, and in a certain number of cases to autoinfection. The last etiologic factor has been especially the subject of discussion by Fromaget, who attributes the condition to an autotoxemia. Elschnig is satisfied that certain cases of iridocyclitis which follow operation may be caused by digestive disturbances, either reflexly or by the absorption of intestinal toxins.

He also believes that glaucoma following extraction may have a similar determining cause. In a remarkable case of this character recently under my care, on the morning of the sixth day, after a perfectly normal extraction without complications of any sort, pain began, followed rapidly by rise in intraocular tension, and, in short, an attack of glaucoma. In the preceding twenty-four hours the urine, which had been normal in quantity and which contained no albumin, although an occasional cast, fell to eighteen ounces, also there were stubborn constipation and other indications of gastrointestinal disturbance. With the relief of these symptoms and the restoration of the urine to the normal amount, associated with myotics locally, the entire attack subsided, to be repeated twice afterwards, in, however, much milder degree, again with a return of all of the symptoms, in so far as the urine and intestinal tract are concerned, which have just been described. The ultimate result was a brilliant cure, with a vision with correcting lenses of fully normal degree. It will at least be admitted that a gastrointestinal intoxication may have been responsible for this complication, although it is not proved. John Green, Jr.,[14] reports a case of juvenile glaucoma, preceded by optic neuritis which he thinks, with reason, may have been due to the resorption of noxious material from the intestinal canal.

Elschnig believes that many cases of chronic choroidal disease may be due to gastrointestinal intoxication, but is unwilling to state more than that this condition should be regarded as a probable cause. The relationship of this form of toxemia to plastic choroiditis will be dealt with to a certain extent by Dr. John T. Carpenter, in his paper on plastic choroiditis to be read at our present meeting, and therefore I will leave details to him. In common with many of my colleagues, I have felt that in many of these cases we must look for etiologic factors not gathered from the usual sources of syphilis, tuberculosis, scrofulosis, and the like, but from some toxin, and therefore from one that may be well attributed to enterogenous decomposition products. The important point, again, is the necessity of a search from this standpoint and the establishment of a dietetic and therapeutic regimen according to the conditions which have been found.

In so far as diseases of the lids are concerned, two important and troublesome affections should be mentioned, namely, recurring styes and various types of blepharitis. To styes Elschnig refers, and is satisfied that the discovery of indican in abnormal degree in these cases indicates their probable origin. The same is equally true of blepharitis. Modern dermatologists have recognized the important relationship of gastrointestinal toxemia to certain diseases of the skin, and many of their most cation, but by vigorous antisepsis of the gastrointestinal brilliant results are not achieved through topical medicanal.

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[14] Green: "Amer. Jour. of Ophth., vol. xxii, 1905, p. 318.

In a recent conversation with Professor Duhring, one of America's most distinguished dermatologists, he impressed on me the absolute importance of investigation of the urine and treatment of the intestinal tract under these conditions, and urged me to make similar searches in the various chronic inflammatory conditions of the lid which we are so prone to encounter. We are only too often content with the corrections of refractive errors and the giving of some resolvent or stimulant salve, and while these are most important adjuncts in the treatment, they are not sufficient.

## TREATMENT.

In so far as treatment is concerned, Elschnig believes that diet occupies an important position, and must be exclusively milk or mixed, according to circumstances. Calomel, in his experience, is a sovereign remedy, and he believes thoroughly in intestinal disinfection by the administration of guaiacol carbonate. Discussing this remedy with Dr. H. A. Hare, I find he also is satisfied that in many instances it furnishes him the best results in so far as intestinal antisepsis is concerned.

## CONCLUDING REMARKS.

This communication is presented to the Section, not with the idea that it has in any sense reviewed the elaborate and conflicting literature of autointoxication, or that it has done anything more than to add to Elschnig's earnest advice that in the diseases already recited examinations should be made in accordance with the best methods of modern physiologic chemistry, that, in other words, we should not be satisfied with the ordinary routine, so-called alterative treatment, but that even so apparently simple a disease as scleritis, or certain types of recurring corneal ulceration, and particularly the various types of uveitis which have been described, should be the signal for patients to be submitted to an examination as thorough as modern clinical medicine can yield.

To summarize: Although we do not know the entity of a single autointoxication except the acidosis of diabetic coma, and although we know that no known autointoxication is to be attributed to any known end product of any known metabolism, to quote Alonzo Taylor, we do know, from clinical analogy, at least, that autointoxications exist, even if their true nature is as yet a secret. We do know, too, that after food is swallowed and before the end products of assimilation are eliminated, there may be processes arising under abnormal conditions which yield poisonous products foreign to normal metabolism, the reabsorption of which may be followed by definite symptoms. We have reason to believe, in the absence of other causes, that under these conditions ocular troubles may also arise largely in the corneoscleral and uveal tracts, and probably, in so far as the nervous apparatus is concerned, in manifestations to which we apply the term acute or chronic retrobulbar neuritis. We do not know whether these toxins, whatever they may be, actually are the only and sole cause of these conditions, but such examinations as have been made by Elschnig, by Kraus, by Groyer, by Edsall and by myself, at least indicate that, to use Elschnig's term, they may be considered accessory causes. As Edsall and I have said, they may be able to play a certain part in the production of the symptoms, and at times are probably the direct cause of their continuance, even when other more commonly accepted etiologic factors have ceased to be active.

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CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# THE EYE INJURIES OF INDEPENDENCE DAY.

## AND WHAT HAS BEEN ACCOMPLISHED IN BALTIMORE TOWARD LESSENING THEM. A FURTHER CONTRIBUTION TO THE SUBJECT.*

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At the last Atlantic City session of this Association I presented a paper on the subject of the eye injuries of Independence Day. Thanks to the admirable work of THE JOURNAL of the Association, I was able to gather much valuable information bearing on this subject. The very fact that three years ago on July 4 nearly five hundred persons were killed, twenty-five individuals were made totally blind, and ninety-five others lost an eye apiece indicates that there is something radically wrong and strongly suggestive of lawlessness in our American civilization. The subject has especially interested me, for every year I have had brought to my notice cases which illustrate forcibly the great folly of the popular way of celebrating our Independence Day.

For example, on July 4, 5 and 6, 1888, there were sixteen cases of eye injury treated at the Presbyterian Eye and Ear Hospital, and on the same days of 1897 there were fourteen cases treated, and in the intervening years there was an average of six cases for every Independence Day. Now and again there has been an outbreak of what might almost be called an epidemic of this class of injuries. For instance, on July 4, 1898, we had a record of fourteen cases at the Johns Hopkins Hospital. In 1899 there were sixteen cases treated at the Presbyterian Hospital, and in 1901 thirteen cases. It should be remembered, too, that a certain number of cases are treated in other hospitals in the city, and then, again, a certain number are treated by other physicians in their private offices. This number would, no doubt, be multiplied many times if the record of every case could be reached. On July 4, 5 and 6 eighty-four cases of this character were observed at the New York Eye and Ear Hospital, a year later forty-two were treated, and in 1905 twenty-two were treated. In 1904 there were sixty-nine cases treated in the leading eye hospitals of New York City. I have collected nearly 500 cases of eye injury, more or less serious in character, caused by the explosion of fireworks, and all these occurred within the last few years. Two hundred and fifty were seen in Baltimore. This may seem a large proportion for Baltimore, but my records go back further in the case of Baltimore than they do in the case of either New York or Philadelphia.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

Of these cases, 357 were children and 100 were 21 years and over. There were 3 cases where the child was 3 years old, five cases where the age was 4, seven cases where the age was 5, one case where the child was 2½ years old, and an infant of 3 months. I have gathered enough information to show that some variety of firecracker was usually responsible for the injury, particularly for the very serious ones. Sky rockets and Roman candles, however, were not found to be blameless. The chief injury was one in which at the same time the lids, conjunctiva and cornea were peppered with grains of powder which was usually found imbedded in these parts, and this injury we all know entails considerable suffering and frequently leaves permanent scars. Of these there were 269. In forty cases the injury was so serious as to make it necessary to take out the eye in seven instances for fear of sympathetic disturbance, while in the remaining thirty-three cases the vision was permanently impaired either by traumatic cataract or by inflammatory changes in the deeper structures.

I am sure there is an ordinance in nearly all of our large cities which prohibits the harmful and pernicious practice of setting off fireworks in the streets. Apart from the danger to person, the danger from conflagration is very evident. In Baltimore there are usually from twenty to thirty fires on July 4, and I believe all of our cities pass through this sort of experience on Independence Day. What has been done to bring about a change of affairs in Baltimore? Briefly, it may be said, first, that it is very difficult to accomplish anything in a movement of this kind without the aid of public sentiment. Generally speaking, the press has been in favor of stamping out the nuisance, but, with the exception of the *Sun,* no paper has expressed itself vigorously on the side of law and order. There is a fine of $2.00 for selling fireworks and of $5.00 for setting them off in the streets. I laid all of the statistics before some of the *Sun* people, and especially the statistics of those injuries which occurred here in Baltimore and which I had collected from the various hospitals. These things were all embodied in several articles in this paper, which, as is generally known, is one of the strongest newspapers in the country. In this way public sentiment was molded. It was shown that our objections rested on the most solid sort of foundation. Letters to this paper appeared from various sources, but the spirit of reform predominated throughout, with the exception of some discordant notes.

I laid the whole matter before the police commissioners, who called together the captains of all the districts in the city and gave them the most stringent orders to enforce the law. The Fourth of July, 1904, showed thirty-six accidents, two of these being eye injuries. At the Presbyterian Eye and Ear Hospital there was not an injury of this character, for the first time in twenty years. The other thirty-four injuries were burns in various parts of the body, and of this latter class there had been, the year before, between one and two hundred. Last year the matter was revived in ths same way, and the result was ten injuries in all, three of these being eye injuries. In this quiet way I believe much can be accomplished by ophthalmologists in every city. I do not believe that the time is yet ripe for national legislation. We will have to educate public sentiment still further on this question and get them used to quiet and sensible Independence Days, and in due season laws may be passed which will prevent the sale of fireworks, even in the so-called "original package."

CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# INJURIES TO THE EYE WITH BIRDSHOT.*

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I have recently had under my care two cases in which the eye was injured with birdshot, both having double perforation. The histories, briefly, are as follows:

Case 1.—E. B., aged 30, was accidentally shot, November 16, from a distance of 35 yards, while hunting, one shot penetrating the left eye. The injury took place in North Carolina, and it was not until about 5 o'clock of the afternoon of the next day that I first saw him.

*Examination.*—There was a penetrating wound of the left eye, exactly in the limbus, at the nasal end of the horizontal diameter of the cornea. The lens was partially opaque, there was no prolapse of the iris, but there was a coloboma toward the nasal side, as clean as if it had been an operative coloboma. Apparently a piece of the iris had been torn loose and carried out of sight. There was no evidence of any infection, though the ocular conjunctiva was much injected. There was some swelling and discoloration of the lids. Vision was reduced to perception of light. Numerous other shot had penetrated other parts of the face, and also the right shoulder. A probe introduced into one of these wounds passed in fully ⅜ in. before touching the shot, from which it seemed very likely that the one which had entered the globe had passed clear through the latter.

*Treatment.*—The eye and conjunctival sac were thoroughly cleansed, atropin was instilled, and the patient was sent at once to the hospital. Here the treatment consisted in boric acid irrigation, atropin, and bandage. There was never at any time any evidence of infection or even of iritis. The pupil was easily dilated and kept so. But as the perforation gradually healed, it was evident that shreds of the lens capsule were incarcerated in the tissue of the cicatrix. As this contracted there was traction through the lens capsule on the ciliary body, as the wound was exactly through this important structure. As the connective tissue continued to contract, lachrimation and photophobia became prominent symptoms, and the eye looked red. The patient, however, was very averse to enucleation, so the good eye was carefully watched, and its accomodative power was daily tested. About six weeks after the injury the patient had excessive photophobia in the right (uninjured) eye, so much so that it was almost impossible to separate the lids to examine the eye. He had had some slight conjunctivitis in both eyes for two days previously, which made the eye somewhat injected, but the iris and media were clear, and the fundus and vision normal. Nevertheless, it seemed very risky to postpone enucleation any longer, with such evidences of sympathetic irritation present, and on December 28, the injured globe was removed. No *x*-ray picture had been taken in the case. The recti muscles were divided, under holocain and cocain, then a little gas was administered in completing the operation, as the patient did not wish to take ether.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in The Journal A. M. A. later.

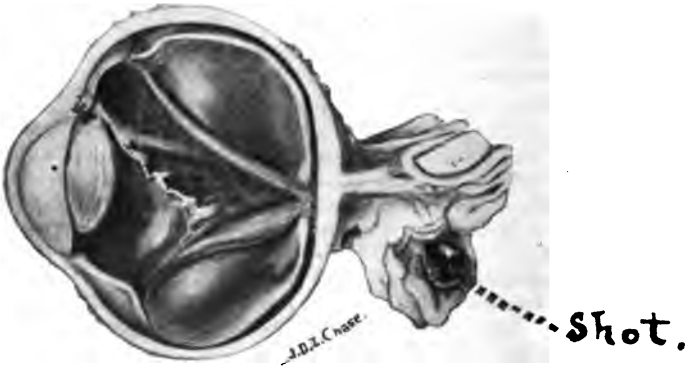

Figure 1.

Inasmuch as I suspected a double perforation on account of the depth to which the other shot in the face had gone (⅜ in.), I divided the optic nerve very far back, (14 mm.) of the globe, and had reason to congratulate myself that I had done so. For on completing the separation of the oblique muscles, I discovered a mass of hyperplastic tissue adherent to the posterior wall of the globe and optic nerve in which, close to the nerve, on its temporal side, and 10 mm. back of the globe was found the shot (Fig. 1). The shot had passed out of the globe just to the temporal side of the optic nerve. Vision was never more than perception of light, and finally not that in all portions of the field.

CASE 2.—Geo. L. aged 34, was shot in the face from a distance of 25 yards, November 22, 1905, while out hunting. Both eyes were penetrated with shot, and the left one was so badly injured that two days subsequently, it was removed in Birmingham, Ala., near which place he had been hunting.

*Examination.*—I first saw the patient twelve days after the injury, December 4, 1905, when the following condition was noted: The left eye had been enucleated. Right eye, pupil dilated *ad maximum* (atropin). The eye was absolutely free from any evidence of irritation, the sclerotic presenting its normal white appearance, except at one small spot, located 6.5 mm. vertically below the temporal end of the horizontal diameter of the cornea. This spot, which has possibly a diameter of 2 mm. or less, is of a dark color, with slight injection surrounding it. Evidently, this was the point of entrance of a shot, and the patient informed me that a probe was passed a little way into this opening (now closed) by the oculist whom he first consulted in the South. The cornea and iris were of normal appearance, and the lens was uninjured and transparent, but with oblique illumination masses of blood clots could be seen in the vitreous, and no red reflex could be obtained, except in the extreme upper periphery of the fundus. The whole lower two-thirds of the background of the eye gave no red reflex and were absolutely dark. The patient counted fingers at three feet with good projection.

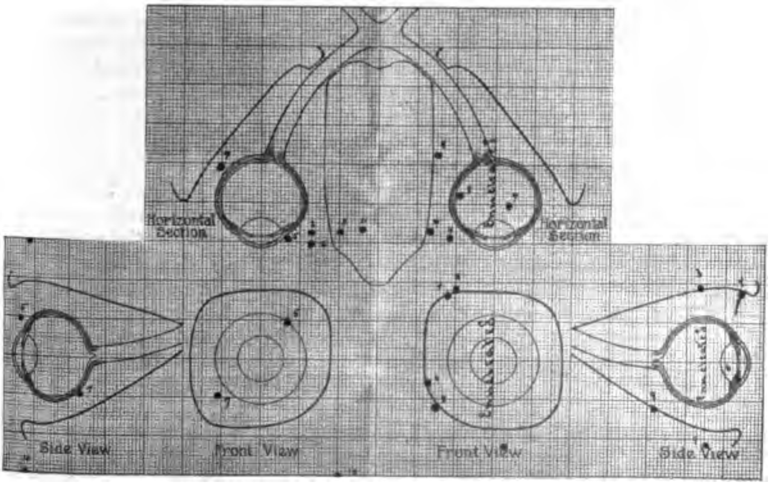

Figure 2, half size.

*Treatment.*—He was sent to the New York Eye and Ear Infirmary, where he was under treatment from December 5, 1905, till February 11, 1906. He was put to bed, given 40 gr. of salicylate of soda daily for three days, when this was stopped, and iodid of potash, at first 30 gr. increased to 50 gr. daily. Atropin was instilled for two weeks, then discontinued. He was also given fluid extract of jaborandi, 30 m. daily, for a couple of weeks in January, going to bed after the dose, and wrapping up warm to encourage diaphoresis. The day after his admission Dr. Dixon very kindly took an *x*-ray picture and localized 14 shot. (Fig. 2). Three of these were in the left orbital cavity. The shot which had entered the right eye was localized about 1 mm. back of the globe, at its temporal side below, having penetrated the sclera at the point described above, thence passing through the lower segment of the globe, almost on a horizontal line, and making its exit through the sclera behind (No. 7 in the cut). His vision slowly improved without any very evident ophthalmoscopic change.

*Result.*—December 13, ten days after admission, his vision was fingers at 40 feet, though movements of the eye would often be followed by lessening of the vision. January 10, one month after admission, vision was 20/70; two weeks later it was 20/50, and two months after admission, February 7, the vision was 20/30. When I say that it was 20/30, I mean that the patient could read promptly down through the 20/50 line, but from there on down, he would have to make frequent movements of the eye so as to shake the opacities to one side. By occasionally repeating these movements, he would complete the 20/30 line. At this time he could read Jaeger No. 8 at 30 cm. February 24, vision was 20/30 and he could read Jaeger No. 4 at 30 cm. On March 5 he read all but one letter of the 20/20 line and also Jaeger No. 2 at 30 cm. At this time I made a note that the area above where details of the fundus could be made out ophthalmoscopically, was a little larger than when I first saw him, but that the region of the disc and macula was just as invisible as it had been three months before. The patient stated that the cloud before him seemed to be thinning out, and the chinks in the opacities to be getting larger. March 31, the vision was 20/20 minus one letter, and he could read easily Jaeger No. 2 at 30 cm., and more slowly No. 1. While opthalmoscopically, there are still numerous large opacities in the vitreous, open spaces are now beginning to show, and today for the first time I got a glimpse of the optic nerve and vessels. The patient walks along the street very independently, though he still has to shake his head occasionally to clear things up. Still, the improvement has been most gratifying, and I anticipate that this improvement will continue, and that he will ultimately get a very useful eye.

He has been taking iodid of strontium, 30 gr. daily, ever since he left the hospital, on February 11, 1906. It was for a long time a constant surprise to me how well he could see, but how little of his fundus I could see when I looked into his eye with my ophthalmoscope.

## DOUBLE PERFORATIONS.

In considering the interesting features of these two cases the first thing to be noted is that they were both cases of double perforation, and such are not at all infrequent among cases of injury to the eye by birdshot. In a more or less careful perusal of the literature I have found eight or ten cases in which the diagnosis of a double perforation was made either ophthalmoscopically or discovered after enucleation of the eye, and it is by no means sure that such was not the case also in many others not reported as such.

The importance of making the diagnosis in these cases of double perforations was early recognized by the ophthalmologist, and their symptomatology was carefully studied. If other shot had penetrated to a considerable depth in the patient's face or body (in my first patient the fact that one shot had gone over 3/8 in. deep into the patient's cheek led me to suspect a double perforation); if there were paralysis of the ocular muscles or retrobulbar hemorrhages with exophthalmos, such symptoms pointed to the probability of a double perforation, provided a second shot had not entered the orbit without perforating the globe. Extreme care was necessary in excluding such a condition, for a perforation of the globe by one shot, and the passage of a second shot into the depths of the orbit (without touching the eye), the latter shot injuring some retrobulbar structures, has been met with in not a few cases.

But all these methods of diagnosis, however intelligently worked out, do not in any way compare in accuracy with the skiagraph. One has only to read the reports of these cases published ten years ago, or even less, to appreciate what surprising advances have been made in the treatment of such cases by the *x*-ray. There is no question but that a considerable number of eyes were removed quite unnecessarily in cases in which, on enucleation, no shot was found in the globe, but a second perforation through the sclera behind.

An instance of such an unnecessary enucleation of an eye is that of Milbradt,[1] published in 1890, and there are numerous similar ones to be met with in the literature of the subject in which, if the case were treated today, the eye would be preserved.

In my first case no *x*-ray picture was taken, and while I felt pretty confident that I had to do with a double perforation, for the reason stated above, and acted accordingly in doing my enucleation, there was not the

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1. Milbradt: Inaug. Diss., Greifswald, 1890, Case 2.

feeling of certainty which was present in the second case, after Dr. Dixon had so accurately localized the penetrating shot, back of the globe. There can be no question, therefore, but that in perforations of the eye by birdshot, just as is the case where the penetrating object is a particle of steel or any other foreign body, the first thing to do is to have an accurate skiagraph taken. We are then in a position where we can intelligently treat the patient and give a much more positive prognosis.

Gengnagel[2] reports a curious case of double perforation of the cornea, in which the shot had entered this structure in the lower temporal quadrant and passed out through the nasal limbus, with prolapse of the iris in both wounds.

In my first case the shot passed through the globe and was found lying in contact with the optic nerve 10 mm. back of the lamina cribrosa. Several interesting cases have been reported, the first by Schweigger,[3] in 1873, another by Vossius,[4] in which immediate and permanent blindness has resulted from the injury, followed in some weeks by atrophy of the optic nerve. In such cases the optic nerve had evidently been injured or lacerated by the shot. In most of the cases the normal appearance of the vessels on the disc indicated that the injury to the nerve was back of the point where the central vessels entered it.

In a case of Gengnagel's,[5] while the ophthalmoscope subsequently revealed an atrophic papilla, the vision became finally 6/12, with contracted fields. In most of these cases of injury of the nerve the shot had not penetrated the globe, but had entered the orbit at one side. Much more serious results than the loss of an eye are possible, for the shot may penetrate the brain and meningitis and death result, as in an interesting case reported by Steindorff.[6] The patient, a little girl, was shot from a distance of six feet in both eyes, the left being perforated, the right not. Death resulted in one month from meningitis, the symptoms of which were very characteristic. At the autopsy a shot was found in the temporal lobe and another on each optic nerve near the foramen opticum. On the right side, while the shot had not torn the nerve, there was in the adjacent sheath an extensive hemorrhage, and the peripheral layers of the nerve were infiltrated with round cells; ophthalmoscopically, marked atrophy was present. In my own case the optic nerve near the shot was left for the macroscopic specimen, and the media were so clouded as to make an ophthalmoscopic examination impossible. Examination of the rest of the nerve microscopically showed no atrophy.

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[2] Gengnagel: Inaug. Diss., Giessen, 1894, p. 22.
[3] Schweigger: Klin. Monatsbl., vol. xii, p. 25.
[4] Vossius: Klin. Monatsbl., 1883, p. 282.
[5] Gengnagel: Loc. cit., p. 10.
[6] Steindorff: Inaug. Dissert., Halle, 1898, p. 52.

Kretschner[7] reported a case in which pulsating exophthalmos came on some three or four weeks after the accident, due, probably, to an injury (aneurism) either of the orbital artery or, as Sattler[8] thinks, caused by a communication between the carotid artery and cavernous sinus. Kretschner's case had also nausea, slight chills and vomiting, so that such symptoms can be present without the existence of meningitis.

A case presenting a curious medicolegal aspect was reported by Weiss[9] in 1898, in which a man was shot in one eye immediately after two hunters had discharged their guns, one of whom used No. 7 and the other No. 9 shot. The eye when enucleated had a double perforation and Weiss could not localize the shot in the orbit. So that the victim who wanted to sue some one for damages did not know against whom to bring suit—the man who used No. 7 or the man who used No. 9 shot! I venture to say that if Sweet, of Philadelphia, or Dixon, of New York, had taken the skiagraph they would have supplied him with the necessary information!

It is not necessary that the globe should be perforated by the shot in order that serious injury to the eye should result, as numerous cases demonstrate. The shot may either pass alongside of the globe (glancing against the latter) into the depths of the orbit, or it may strike against or penetrate the lid, but not pass clear through the latter. In either case the eye may be seriously injured, possibly by *contre-coup*.

Lindenmeyer[10] reports a case where the shot struck the lower lid, but did not penetrate the latter. There was no perforation of the globe. Vision at first was entirely lost. Three days afterward the patient could count fingers at three feet, there were thick masses of blood in the vitreous and the pupil was small. Later choroidal rupture could be made out after the blood had been absorbed (three weeks) and vision was 5/15.

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[7] Kretschner: Centbl. f. prakt. Augenhk., 1889, p. 112.

[8] Sattler: Graefe-Saemisch, first edition, vol. vi, part 2.

[9] Weiss: Klin. Monatsbl. f. Augenhk., 1898, p. 10, 350.

[10] Lindenmeyer: Sammlung aus dem Gebiet. der Augenhk. (Vossius), vol. v, No. 1, p. 6.

One must not conclude too hastily, therefore, that the eye has been penetrated when, after these accidents, the vision may be abolished and the vitreous full of blood. Careful investigation should be made to ascertain whether the damage is the result of a perforation or merely from the impact of the shot directly, as in the last case, or by a glancing shot, which subsequently has buried itself in the orbit.

Among the conditions found after injury of the eye with birdshot, either with or without perforation, are rupture of the choroid and retina, one or both, commotio retinæ, retinal and intraocular hemorrhages, cataract, injury to the nerve, paralysis of various ocular muscles, pulsating exophthalmos, and finally meningitis and death.

### PROGNOSIS.

In discussing the prognosis I will consider it first as to the preservation of the globe and, second, as to the recovery of useful vision. So far as the preservation of the globe is concerned, this will depend much on the location of the perforation. In my first case the shot passed exactly through the limbus, damaging in its passage the ciliary body and lens. Into the cicatrix the lens capsule became incarcerated, and we had to deal with conditions exactly similar to those present in the case of a penetrating wound in this region by anything else, and we all know how prone such are to set up sympathetic trouble.

Several cases have been reported where the shot penetrated this region, and they all required enucleation. In a case of Valois[11] iridocyclitis developed in three months, necessitating enucleation. He states that iridocyclitis may also develop if the shot at first fixed in the vitreous or elsewhere becomes loosened and falls on to the ciliary body. The *x*-ray can be employed, however, to show whether such change in position has taken place. Of course, if the victim is so close to the gun that numerous shot pierce and lacerate the globe (as was the case in the left eye of my second patient, according to what was reported to me), immediate enucleation is the only possible course to pursue.

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[11] Valois: Rev. d'Ophthal., 1901, p. 71.

Aside from these two conditions, viz., a lacerated wound through the ciliary region (and even here expectant treatment for a while may be advisable) and the laceration or disorganization of the globe by numerous shot entering it from close range, the prospects of saving the globe are very good.

Fornatola[12] reported in 1894 twenty-two cases (he has since reported many others), and stated that most cases in his hands showed very little reaction, and out of the twenty-two he only had to enucleate one eye, and this patient had neglected treatment. In my second case the right eye was never infected, nor did it give any evidence of the slightest irritation.

So far as the visual prognosis is concerned, that will depend on the structures through which the shot passes. Where the course of the latter is through the peripheral structures, and especially where there is a double perforation, as in my second case, the ultimate result may be good. In this class of cases the visual disturbance is principally due to hemorrhage into the interior of the eye, and it not infrequently takes several months, or even a year, before the maximum of visual improvement has been reached. In Snell's case,[13] in which the globe was filled with blood, the absorption at first was rather rapid and in nine months vision was normal. It is now five months since the accident occurred in my second case, and his vision is now 20/20, and I am sure absorption will continue for a long time. In any individual case of perforation with blood in the interior it is not easy to give a very positive visual prognosis. Some cases improve more or less slowly, while others remain unchanged, notwithstanding patient and long continued treatment. A case under the care of Dr. Percy Fridenberg[14] for months had finally vision ability to recognize the movements of the hand a short distance away. Of Fornatola's twenty-two cases, eight recovered vision more or less good; in two cases it was 20/20.

*Prognosis When Shot Remains in the Eye.*—While Leber considered lead as one of the metals likely to set up inflammation in the eye, the majority of observers consider the presence of shot in the eye as relatively harmless, though, of course, their situation is important, for if they rest on the ciliary body they are apt to produce trouble. Bürstenbinder[15] presented a patient in Hamburg in 1901 who had been shot in the left eye eight years previously. There had been a shot in the anterior chamber, at the iris angle; the eye was perfectly quiet and vision was 1/3. In a case of Gotti's the shot was in the periphery of the anterior chamber for one year, when irritation set in and the shot was removed.

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[12] **Fornatola: Rev. gén. d'Ophtal., 1894, p. 206.**
[13] **Snell: Ophth. Rev., 1893, p. 156.**
[14] **Fridenberg: Deuts. med. Wochft., 1897, No. 46.**

Schneider[16] in 1877 reported the case of a soldier who, standing near a target, was struck in the eye by the splinters of a bullet which had struck the target near him. Vision was at first completely gone, and gradually rose to 20/50. in two years, when he was first seen by Schneider. There was a pupillary membrane in which were several bits of lead the size of a pinhead; there were two or three larger pieces movable in the vitreous, and two imbedded in the retina. There was no irritation of the eye, and all the pieces of lead had entered through the same wound in the limbus. Fornatola reported twentv-two cases, and in one only did he have to enucleate. He experimented with infected shot fired into gelatin which remained sterile. He then shot into rabbits' eyes and found that if the lids had been previously sterilized, and if the eye was protected from the subsequent external infection, the shot became encapsulated. Ovio[17] and Rolland[18] repeated these experiments and found that shot infected with the spores of the anthrax were the only ones which were not rendered sterile by the discharge of the gun. Shot infected with other germs, as the *Staphylococcus pyogenes,* were demonstrated to be sterilized, either by the heat of the discharge or by the friction of the passage of the shot through the air, or gun, one or both.

Our chairman, Dr. L. A. Taylor, in a paper read before this section in 1897, stated that on examination of an ordinary birdshot shell he found covering the powder a series of wads, at least ¾ in. thick, so that it was not probable that any of the flame from the powder explosion could come in contact with the shot. Whether all shells are made alike or not I do not know. Experi-

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15. Bürstenbinder: Centbl. f. Augenhk., 1901. p. 328.
16. Schneider: Klin. Monatsbl. f. Augenhk., 1877, p. 292.
17. Ovio: Rev. gén. d'Ophtal., 1895, p. 305.
18. Rolland: Rev. d'Ophtal., 1887, p. 530.

ments, however, have been repeated now by numerous observers, so that there can be little doubt as to the fact that in most all cases a shot from a gun is sterile if it has not come in contact with anything else in its flight. How this sterilization is produced is not quite clear.

### TREATMENT.

If the eye is lacerated or badly torn by the entrance of several or numerous shot, as happens if the victim of the accident is very close to the gun, immediate enucleation should be done. When there is a single perforation the important thing is to protect the eye from infection. The only case of Fornatola's twenty-two which required enucleation was one in which treatment was begun late, and the cases in which treatment was postponed or discontinued too soon all proved troublesome. The conjunctival sac should be cleansed if the swelling of the lids permit it and a bandage applied.

If there is much swelling of the lids ice applications should be made and the patient should be put to bed. Of course, if there is prolapse of the iris the wound should be freed from this by excising what is prolapsed. The patient should be treated in this careful, systematic manner until the wound is thoroughly healed and all danger of external infection is past. If there is much gaping of a scleral wound, conjunctival sutures should be introduced to close it as well as possible.

One thing which should not be done is to introduce a probe, for this is a crude way of undertaking localization, and can only add to the risk of infection. An accurate *x*-ray picture should be taken as soon as possible. If by this a double perforation is shown, the eye can probably be saved, provided the ciliary body is not lacerated and infection does not take place. When the vitreous is full of blood the iodids, either of strontium or potassium, have been usually given, and probably are useful in assisting absorption.

If the shot is still in the eye the latter can still, in all probability, be saved, as the history of a great many cases show. The reaction in many of these cases is surprisingly slight if promptly and carefully treated. If the shot is in some position easily accessible, as in the anterior chamber, an attempt should be made to get it out. If, however, it is in the vitreous or other place not easy to get at, I think it should be left undisturbed in the hope that it would become encapsulated, as has often occurred. Now that the *x*-ray can tell us exactly where the shot is located, we can treat these cases much more intelligently. If it is resting on the ciliary body, or if originally in some other position, it has shifted, so as to rest on the ciliary body, it will in all probability set up irritation. In such a case an attempt to remove the foreign body would be warranted, and if it failed the eye could be removed.

A considerable literature is appended to the articles of Pahl[19] and Lindenmeyer.[10]

46 West Fifty-third Street.

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[19] Pahl: Inaug. Dissert., Greifswald, 1898.

CHICAGO:
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1906.

# THE RIPENING OPERATION FOR IMMATURE SENILE CATARACT; ITS PLACE.*

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The earlier belief that a patient must await the time of complete maturity of a cataract before extraction could be performed with safety, led to the development of various artificial methods to hasten ripening. But this meant the performance of a preliminary operation, and Schweigger, in 1890, advocated the removal of immature cataracts after the age of 50, claiming that sufficient hardening of the lens has taken place at this age to enable the operator to remove the entire cortex. Many operators have followed and advocated this practice and the number seems to be constantly on the increase.

Yet it is a fact that ripening operations are still practiced by some surgeons with success, in all cases in which conditions make it humane not to wait for nature to bring about maturity, in preference to extracting an unripe cataract, while many other operators often perform the ripening operation under like conditions. Thus there seems to be a great difference of opinion regarding this very important question.

The ultimate question to be determined is, whether in those cases in which, for reasons to be mentioned later, we think it unwise to wait for maturity, we shall always extract an immature cataract, always perform a preliminary ripening operation, or whether there are not cases in which it seems best to do a ripening operation, and other cases in which the extraction of an immature cataract seems the wiser course. It is for this purpose that I present this subject at this meeting, and ask for the experience of the members of the section.

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*This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

In years past this section has discussed the ripening operation,[1] and last year it expressed the almost unanimous opinion, in answer to Dr. Bulson's[2] inquiries, that it believed the practice wise, in selected cases, either to remove an unripe cataract or to perform trituration and then to extract. In order to secure the most recent expression from operators of experience, I have addressed letters to many prominent ophthalmologists of the United States, from whom sixty-nine replies have been received. These replies form a supplement to my paper, and for the detailed statement of the questions asked, with their replies, the reader is referred to this portion of the paper.

As evidence that trituration has not yet been discarded by many operators, the fact should be noted in these replies that twenty-six surgeons still practice the operation when occasion demands, that four rarely practice it, but nineteen who have had some experience now do not practice it at all, preferring the extraction of immature cataract, usually with irrigation. Of those who continue to practice trituration with satisfactory results, note the opinion of Colburn, who has operated on forty-seven patients; of Ayres,[3] Wescott, White, Prince and others, who frequently practice intraocular massage with preliminary iridectomy, and have satisfactory results; of Ball, who has had much experience and similar results; of Wilder, who practices Forster's method in "certain cases" in which he performs preliminary iridectomy, but otherwise prefers to extract an immature cataract. The following significant paragraph is by de Schweinitz:[4]

> The safest plan is to wait for maturity; but if this is impossible or very undesirable, the author has been in the habit of extracting an unripe cataract in preference to performing a ripening operation. This formerly was also the practice of Knapp; but recently he has ripened immature cataracts in a certain number of cases by the method of internal trituration, as employed by Boerne Bettman[5] and others, and has been satisfied with his results.

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[1] Weeks: "Treatment of Immature Cataract," THE JOURNAL A. M. A., p. 955, Sept. 30, 1905; also de Schweinitz: "Immature Cataract and Its Treatment," THE JOURNAL A. M. A., p. 1467, Dec. 8, 1906.

[2] Bulson: "The Extraction of Uncomplicated Immature Senile Cataract," THE JOURNAL A. M. A., Sept. 23, 1905, p. 905.

[3] Ayres: "Artificial Ripening of Cataract," Cincinnati Lancet-Clinic, Oct. 10, 1896.

[5] Boerne Bettman: "Ripening of Immature Cataracts," Ann. of Ophth. and Oto., Jan., 1893.

That Knapp approves of artificial ripening under certain conditions is shown by his opinion expressed at the end of this paper.

On the other hand, however, note the statement of Risley, who tried a series of twenty-five cases, mostly by trituration directly on the capsule, and does not think his results were as good as after extraction of immature cataracts. He has entirely given up the operation, and does not think it is to be commended.

Many others, as Kipp, Callan, Lewis, Hubbell, Bull, Ellett, Griffin, Reynolds and Posey performed trituration formerly but never do so now. Others, as Taylor, M. Black, and Carrow, have not cared to practice the operation, having secured satisfactory results with premature extraction and irrigation.

There is only one point on which there is a general agreement, and that is, regarding the question of determining in what cases we shall not wait for maturity.

With one exception, all believe that, under the circumstances to be mentioned later, either an immature cataract should be extracted or a preliminary ripening operation performed; but Fox, in answer to Bulson's questions a year ago, states: "I do not extract immature senile cataracts, for I do not believe in taking the risk of serious secondary complications which nearly always take place, and render the ultimate results unfavorable;" and in reply to my question as to whether or not he ever performs the ripening operation, he states: "I do not," but modifies this statement, in answer to the question: "Under what circumstances would you perform the operation," by saying: "Only when the nucleus is translucent or sclerosed, and it becomes imperative to obtain better vision quickly." He further says: "It is always dangerous to operate on an unripe cataract. The early removal of an unripe cataract leads to a great deal of trouble."

The methods which have been devised for the purpose of ripening an immature cataract, are:

1. Puncture of the anterior capsule combined with iridectomy (Mooren, 1858).

2. Puncture of the capsule combined with trituration (Rhomer, 1886).

3. Preliminary iridectomy with trituration through the cornea, indirect trituration (Forster, 1881).

4. Trituration after simple paracentesis without

iridectomy (T. R. Pooley[6] operated on rabbit, 1885, and soon after J. A. White operated by this method on a human being).

5. Paracentesis, with or without iridectomy, and direct trituration on the anterior capsule (Ricaldi, 1888, and Bettman, 1892).

From investigation it appears that the last two methods are practiced to almost the same extent. Two operators, Dr. J. A. White and Dr. Edward Jackson, however, practice exclusively and with great success, the method of Pooley. Knapp considers needling the capsule or direct trituration the only efficient method.

Operators of experience disagree regarding the selection of the method of Forster or Bettman. Ayres, Wilder, Prince, Wescott, and others prefer the former. Wilder is strongly opposed to direct trituration, having had two serious results following this method, but Colburn, Ball, Weeks[1] and others prefer it to trituration outside of the cornea.

### THE SAFETY OF TRITURATION OF THE LENS.

Considering the large number of operators who have performed this operation, the number of cases in which ill results have occurred have been very few. Only three are reported in which loss of life resulted, and two of these might be excluded, because one proved to be an unfavorable case (Wilder's), and the other was due to iris prolapse and infection (Colburn's). In one there was so much reaction that later it became necessary to remove the eye. This was Wilder's case, in which he did trituration directly on the capsule, "which, however, was found to have a choroiditis, together with posterior staphyloma, so that it would not have been a favorable case for any kind of intraocular operation." Baker's case was one of glaucoma, in which the eye subsequently had to be removed on account of pain.

There have been a number of cases of iritis, but no cases in which ultimate poor vision resulted, though Wadsworth feels that vision was not so good in some cases (Wadsworth, Callan, Reynolds, Hansell). Four cases of glaucoma were reported, one each by de Schweinitz[1] and Griffin, both ending well, likewise another by Donovan, in which it became necessary to remove the lens. Posey had a case in which he suspected retinal detachment, but if so, it was cured by rest in bed, and the ultimate results were good. With very few exceptions, operators who have had experience do not regard the operation as unsafe in uncomplicated cases.

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[6] Pooley: "A Modification of Förster's Method of Artificially Ripening Cataract." N. Y. Med. Jour., Dec. 26, 1885.

### THE EFFICIENCY OF THE OPERATION.

A study of the opinions expressed shows that the operation is most effective in ripening senile cataracts when a hard nucleus is present and it is in just such cases that the operation would be most needed, but that it is entirely ineffective in young people, and in cases of soft cataract. This is expressed by Dr. Edward Jackson,[7] who practiced Pooley's method. He says: "In the matter of efficiency, my experience indicates that indirect massage is efficient only in senile cataract, that is, only when the opaque lens contains a rather large, firm nucleus." Dr. J. A. White[8] has had some success with the same method in cases of cortical cataract, though he has had to resort to a repetition of the operation in two cases. He also states, however, that the operation is most successful when a hard nucleus is present, which, he says: "Acts as a base on which to crush the cortex." Several operators express some dissatisfaction, i. e., inability always to secure ripening, but do not stipulate the character of cases. Weeks says: "I have not found that the lens substance escapes more readily after the ripening operation than when the immature cataract is extracted," and Knapp, Lewis, Bull and Hubbell make similar complaint of failure in some cases. These, however, are exceptions, and there is not much complaint on this point.

### TIME REQUIRED FOR RIPENING.

From one to four or five weeks are necessary, according to most of the opinions expressed, but extraction is not practiced usually for ten weeks.

It would seem that a second operation for membranous cataract is not required so often after extraction following a ripening operation, as after extraction of immature cataract, though many operators state that they do not think there is any difference in this respect.

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[7] Jackson: "Indirect Massage of the Lens for the Artificial Ripening of Cataract." N. Y. Med. Jour., Oct. 28, 1893.

[8] White: "Remarks on Immature Cataract and the Best Method of Hastening Maturity," Ann. of Ophth., 1892, vol. xxi, No. 4.

## OBJECTIONS TO THE OPERATION.

It does not appear that the objections to the operation by those who have had experience and do not commend it arise from ill results, as these have been comparatively rare, but rather because it is believed by many that an immature cataract can be removed as easily as an artificially ripened one, many believing that the trituration thickens the capsule and causes it to adhere to the lens substance.[9] One operator (Bulson[2]), who prefers the extraction of immature cataract, and presented a paper on this subject before this section a year ago, believes that this is the only place for the ripening operation, i. e., "unless patients having immature cataracts, should, from nervousness or other reasons, give the operator a feeling that but little manipulation at the time of extraction should be employed."

An immature cataract can sometimes be well removed after the age of 60, and even before that time if it is not very immature, but without irrigation before that age, and often after 60, considerable cortical matter is apt to remain, to cause much trouble later with iritis and membranous cataract. The enthusiasm with which those who practice irrigation in cases of extraction of immature cataract (with the apparatus of Lippencott, Carrow or Reik) leads one to believe that it is of great value under such circumstances. Carrow practices irrigation in all cases, ripe or unripe, and extracts "whenever the patient loses reading ability."

Some object to trituration on the ground that it means an extra operation, and this is valid where it is not required, in those cases in which an immature cataract can as well be extracted; but, on the other hand, some operators often perform preliminary iridectomy, which also is an extra operation. Thompson, of Indianapolis, advises preliminary iridectomy in all cases in which for any reason there is doubt regarding successful results. Weeks still practices trituration occasionally when he does a preliminary iridectomy, evidently believing it to be an aid, but not of enough value to warrant the extra operation unless preliminary iridectomy is to be performed.

## CONTRAINDICATIONS AND INDICATIONS.

In no case of immature cataract would operative measures be resorted to when the patient had sufficient vision in the other eye. No definite degree of loss of vision can be defined in exact figures, for other things have to be taken into consideration in deciding the advisability of the removal of, or ripening of, an immature cataract. The slow and equal development in both eyes, of central cataracts; the loss of ability to earn a livelihood when dependent on the same, and especially when others, too, are dependent; the unhappiness which may result to the patient and those about him; and the general and local conditions have to be considered.

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[9] Crumb: "A Unique Point in Removing the Soft Lens Matter from the Capsule of an Unripe or Overripe Lens." Amer. Jour. of Ophth., March, 1899.

I have been in the habit of performing the Förster operation in uncomplicated cases of immature senile cataract having much soft cortex (recognizing the fact that many lenses are hard, even though not opaque, particularly in patients over 60), and in those patients having two eyes with slowly maturing cataracts and poor vision, enough to interfere with earning ability or to cause the patient unhappiness. This has been done with satisfaction. In no case has a secondary operation been necessary, and in all cases good results have followed, but I am not prepared to say that equally good results might not have followed extraction with irrigation, though I am sure irrigation would have been necessary. As an example the following case is reported.

*Patient.*—A. T., male, aged 54, came under the observation of one of my patients, who elicited the following facts:

*History.*—The man had been a barber, supporting comfortably a family of six, up to two years previous, when his sight became so poor that he was obliged to seek other work. He took up the making and peddling of candy, and left his small home town to come to the city. He was not able to earn more than enough to support himself, and his wife was supporting the remainder of the family by taking in washing. He demurred at coming to see another occulist, as he had seen several, and had been told that he would have to wait for his cataracts to mature.

*Examination.*—Showed nuclear cataracts, just about the size of his pupils, equal in the two eyes, and vision 10/200, improved but little with a mydriatic.

*Treatment.*—The patient was advised to have a ripening operation, and the risks were explained. He consented gladly, and a preliminary iridectomy was performed on one eye, with careful trituration outside of the cornea. Three weeks later, the lens, being entirely opaque, was removed, a small amount of cortex remaining. Only slight reaction took place.

*Result.*—He left the hospital two weeks later and soon went home. In three months he returned and was fitted with glasses, giving 20/30 vision. I saw him some months later, and the other lens showed no further development of the opacity. He has returned to his trade, and is able to support his family.

The details of this case are recorded as it furnishes a good example of the circumstances which make it practically imperative that some such procedure should be practiced for humane reasons.

It is evident that the operation is not to be commended in cases complicated with high myopia, choroiditis, or other inflammatory conditions, nor in cases predisposed to glaucoma, nor where adhesion to the iris is present. Nor is it necessary where a cataract is nearly mature, nor in cases of patients over 60, when the cortex is apt to be of such consistency that it may be removed without much difficulty. In such cataracts the cortex may appear translucent, or amber-colored. Nor would it seem necessary in the case of well-behaved patients, when irrigation is used by an operator experienced in this practice. In this matter, I do not speak from experience, for I have not yet practiced irrigation, but I judge from the favorable comments made by colleagues whose judgment I respect, and the fact that the method is gaining in favor despite opposition formerly expressed.

## CONCLUSIONS.

If, therefore, we grant the success and safety claimed by those of much experience in irrigation, the operation of ripening is indicated. 1. In case of immature cataract (not mentioned as contraindicated), in which a preliminary iridectomy is to be performed. 2. In those patients who would not be likely to behave well during the extraction, thus preventing the operator from performing much toilet or from practicing irrigation.

If irrigation is not practiced, trituration of the lens would be indicated in all patients with immature senile cataract under 60, in whom for reasons mentioned, relief is required.

Questions asked were:

1. Do you ever perform the ripening operation in the case of immature senile cataract?
2. Have you had any ill results from the operation; if so, of what nature?
3. Under what circumstances would you perform the operation?
4. If you do not perform the operation, what are your reasons? Are they based on your own experience?
5. Have you secured as good results after extraction following the ripening operation, as after extraction in the case of very immature senile cataract?
6. Do you find from actual experience that an operation for membranous cataract following extraction is required as often

when the ripening operation has been performed, as after extraction of a very immature cataract?

## OPINIONS OF PROMINENT OPERATORS.

**HERMAN KNAPP**, New York: I regard external or internal trituration as efficient, and practice needling the anterior capsule at different places and use irrigation following extraction, but all of the ripening methods are more or less unsatisfactory: their shortcoming is insufficiency. Experience with the ripening operation has made me more conservative than I was formerly. I approve and do an artificial ripening of immature cataract (in selected cases), but prefer to let the cataract ripen naturally.

**J. E. COLBURN**, Chicago: 1. Yes, usually with preliminary iridectomy, direct massage (Bettman), followed in about ten weeks by extraction. 2. None that could be attributed to the procedure. One failure in 47 cases, due to prolapse of iris and secondary infection. Two cases of iritis, making good recovery. 3. When both eyes are involved, sufficient to prevent useful vision, and in monocular amblyopia. 5. Yes. 6. Yes, rather thick in some cases.

**S. C. AYRES**, Cincinnati: 1. Yes. 2. No. 3. When the opacity of both lenses was advancing about equally. 4. I never recommend the operation unless the perception and projection are good, and the eyes apparently healthy. 5. I never extract "very immature senile cataracts." My results after trituration have been very satisfactory.

**A. E. PRINCE**, Springfield, Ill.: 1. I frequently make a preliminary iridectomy in immature cataract, and use extraocular massage of the eye, after the iridectomy is completed. 2. I never had, to my knowledge, any unfavorable result which I can attribute to this operation. 3. I perform the operation usually in cases of middle life, where, from any cause, it is desirable to hasten the time of extraction. 5. I think the results are satisfactory after the ripening operation. 6. I consider the question of whether a membranous cataract is more liable to follow, to depend on the thoroughness with which the irrigation has been carried out. If considerable cortex is taken into the capsule, a membranous cataract would be liable to follow.

**J. MOORES BALL**, St. Louis: 1. Yes, frequently. 2. No. 3. In cases of slowly maturing binocular cataract. 5. Yes. 6. I am unable to say. I performed a number of these operations in the last fifteen years. I am partial to preliminary iridectomy. In nearly all cases in which I make a preliminary iridectomy I also triturate the lens directly, the so-called method of Bettman. I have done thirty or forty of these operations.

**H. V. WÜRDEMANN**, Milwaukee: 1. Yes. 2. No. 3. Slowly progressing lenticular opacities in both eyes of active adults under 60 years of age. Over that age the lens is sufficiently hard to permit of successful extraction, even though nearly clear. 5. Yes. 6. I endeavor (*a*) to extract lens in capsule; (*b*) failing in that, I make large capsulotomy with forceps: (*c*) I use lavage to remove lenticular débris, and hence, in recent years have much smaller percentages of secondary capsulotomies.

**FRANK ALLPORT**, Chicago: 1. Yes. 2. No. 3. When patient is blind in both eyes, but neither lens is ready for operation. Still, I prefer to operate on an immature cataract, rather than to ripen one artificially. 5. Yes.

**C. D. WESCOTT**, Chicago: It is my custom to do a preliminary iridectomy in all cases of immature senile cataract in which I operate. After making the coloboma, I usually stroke the cornea a number of times with the spatula, making sufficient pressure to bring it in contact with the anterior surface of the lense. A few times I have introduced the spatula into the anterior chamber, stroking the anterior capsule directly where it was necessary to use the instrument to replace the pillars of the iris. I believe that the ripening of the cataract is hastened by the iridectomy alone, and still more so by the procedure which I have described, although it can not be proved. My results have been satisfactory. I can not say that the operation for membranous cataract following the extraction is influenced by the procedure.

**W. B. MARPLE**, New York: 1. Only occasionally. 2. I have had no ill results. 3. I perform it less and less frequently and have not done it on any private patient. 4. In the nuclear cataract or sclerosed lens I get perfectly good results, even when vision is still good. If I had a patient whose vision was much impaired in each eye, from ordinary senile cataracts (not sclerosed lenses) which were immature, I would not hesitate to perform a ripening operation, but not if one eye was fairly good. 5. Yes. 6. I have seen no especial difference, as I use irrigation of anterior chamber rather freely.

George C. Harlan, Philadelphia: 1. I have done it in a few cases. 2. No serious results. 3. When opacification is excessively slow, and vision is not sufficient to earn a living. 5. Better. 6. Experience too limited to decide.

H. Gifford, Omaha: 1. Yes, a discission. 2. I have twice had an infection of the lens, one with final good result and one with bad result. Both these cases were in old people. I now do preparatory discission on people under 50 years of age. 3. When in patients under 50 something has to be done to an unripe cataract, or allow the patient to go on indefinitely with poor vision. 5. About the same. 6. I think more often.

Lucien Howe, Buffalo: 1. Yes, occasionally, Rhomer's method. 2. No. 3. Only when the condition of the other eye makes some such hastening essential. 5. About the same. 6. No difference ever observed. I must add, however, that it is still a question in my mind whether this or any other of the ordinary ripening operations does really ripen, at least, in the majority of cases.

S. Theobald, Baltimore: 1. Yes. 2. No, except at times a little rubbing off of the pigment from the posterior surface of the iris, near the pupil, and some iritis, more than would follow a simple iridectomy. 5. Better results. 6. I do not.

Dunbar Roy, Atlanta: 1. Occasionally. 2. None. 3. In cases of preliminary iridectomy. 5. Yes. 6. It is not required as often.

H. F. Hansell, Philadelphia: 1. I have operated in several cases of young senile cataracts, those developing in individuals under 50 years of age. 2. Yes, iritis. 3. In the circumstances mentioned under No. 1. 5. Yes. 6. I have found no difference.

Eugene Smith, Detroit: 1. Seldom. 2. No. 3. To enable patient to work when necessary to support family. 5. Yes, though greater danger of iritis. 6. Yes.

Charles A. Oliver, Philadelphia: 1. Yes. 2. No. 3. Long-standing, uncomplicated (particularly unclean) cases. 5. Yes. 6. No.

William Cheatham, Louisville: 1. Yes, iridectomy with massage on cornea of capsule. 2. No. 3. Any reason necessitating an early operation more often in those cases in which both cataracts are progressing evenly. 5. Yes. 6. Yes. My experience is not large enough for my statistics to be of much value.

N. M. Black, Milwaukee: 1. Yes, occasionally. 2. No. 3. In cases when there was some clouding of the lens sufficient to interfere with vision in a patient who needs to use eyes for purpose of carrying on his business. 5. Practically no good, I think. 6. Can not say.

Lyman Ware, Chicago: 1. Yes. 2. No. 3. In cases of binocular cataract, when necessity compels use of eyes. 5. Yes. 6. Have no data, but think not.

J. H. Claiborne, New York: 1. Yes. 2. No. 3. In slowly growing cataracts, chiefly in myopia, and in persons who can not afford to wait. 4. Yes. 5. Yes. 6. Yes.

C. R. Elwood, Menominee, Mich.: 1. I have not. 3. When both eyes were about equally advanced and ripening slowly, or probably if only serviceable eye was cataractous and ripening slowly. 4. I believe natural ripening safest, and my patients have happened to have one eye much more advanced than the other, or one lens ripe, when presented. 6. My experience has been only after natural ripening. With slowly ripening cataract in patient's only eye, I would do a preliminary iridectomy, and at the same time very carefully massage lens.

Horace M. Starkey, Rockford, Ill.: 1. Yes, the Forster operation as modified by Bettman. 2. No. 3. When vision is reduced in each eye by small, non-progressing or slowly progressing central opacities. 5. Yes, or as in mature senile cataract. 6. Have observed no difference.

A. E. Bulson, Jr., Fort Wayne: 1. Yes, in the few instances in which I have performed preliminary iridectomy before cataract extraction. It is my opinion that preliminary iridectomy alone, without trituration, will hasten maturity of cataract. 2. No. Once had considerable swelling of lens, but it did not prove serious in results. 3. In the few instances in which preliminary iridectomy was indicated. In nervous patients, in whom manipulations to extract immature cataract might be disastrous, and seldom, if ever, in patients beyond 65 years of age, as there are no advantages to be obtained in such cases over extraction of immature cataract. 4. I do not believe advantages, taking all risks into consideration, are more than in extraction of immature cataract under proper conditions (combined operation, irrigation, atropin, etc.). 5. Yes, have only very few cases in which ripening operation was performed. 6. My experience is limited, but would say yes. I have not attempted the ripening operation except in a very few cases, and in all of those I started out to do a preliminary iridectomy with the intention of making extraction later. My experience has been that a preliminary iridectomy alone is sufficient in most cases to hasten the maturity of a cataract. Therefore, inasmuch as I do an iridectomy in all cataract extractions, it occurs to me that preliminary iridectomy is all that is indicated in case the operator does not care to undertake the extraction of an immature cataract by the combined operation. I have had such good results from the extraction of immature cataract that I have not given much thought to the value of the ripening operation, but I believe there is a place for the ripening operation, and I would probably prefer to use the operation, if used at all, in those patients having immature cataracts, who, from nervousness or other reason, give the operator a feeling that but little manipulation at the time of the extraction should be employed.

J. L. THOMPSON, Indianapolis: 1. The only perfectly safe ripening operation for immature senile cataract in my opinion, is a preliminary iridectomy. 2. I have never met with any ill results from this operation. 3. It is called for in cases of nuclear cataract in both eyes, when the acuity of vision is not sufficient for one to read large print, when the patient becomes tired of waiting, as he frequently has to do, for many years. 5. By this method I obtain better results than when I do iridectomy and extraction of the lens in one operation. 6. Fewer cases of thickened capsular threads are met with after this preliminary operation.

J. E. WEEKS, New York: 1. I have performed it, but do not do it now, except in cases in which I perform a preliminary iridectomy directly on the anterior portion of the lens capsule. 2. No, but I have not found that the lens substance escapes more readily, after the ripening operation than it does when the unripe or immature lens is extracted. 3. None, except when preliminary iridectomy was performed. 4. I have not found it to be of sufficient value to make it worth while. My opinions are based on personal experience. 5. About the same. 6. Yes.

S. D. RISLEY, Philadelphia: 1. I did so in a considerable series of cases, but abandoned the operation. 2. Never had any immediate ill results from inflammatory reaction. 3. I would not perform it under any circumstances. 4. My experience very soon taught me, or seemed to teach, that the difficulties of extraction were enhanced. The cortex seemed glued to the capsule, and the capsule itself tough and gray, in cases in which the cortex became opaque after trituration. In cases in which this did not follow, the lens, when amber colored or translucent, was found already hard, and operation therefore was unnecessary. 5. My results after ripening were no better; I think not so good. 6. I have no compiled statistics on this point, but my impression is that it is required as frequently and is usually more difficult because of greater toughness of capsule. I did the ripening operation in 25 consecutive cases of immature cataract, most of them by direct trituration of the capsule, some of them by the method of Forster, but I had such discourgaing results in the subsequent extractions as compared with the results obtained in the case in which the operation had not been done, that I was quite glad when I was through with them, and have never ventured on it since. This was about ten years ago. I do not think the operation is to be commended.

GEORGE E. DE SCHWEINITZ, Philadelphia: 1. Not often. 2. Once only, in secondary glaucoma from swelling of lens, the ultimate result was perfectly good. 3. In very slowly maturing central cataracts with much clear cortex in patients under 50. 4. It is best to wait for maturity, but serious objections to removal of unripe cataract after 60, and do not advocate ripening operations. 5. Yes. 6. Yes.

**W. H. Wilder**, Chicago: 1. In certain cases I perform preliminary iridectomy, and at the same time practice massage of lens through the cornea, according to method of Forster. I never triturate the lens with an instrument pressed into the anterior cornea, as I used to do occasionally. 2. With two cases treated with anterior cornea trituration I had very serious results. In one of these there was violent reaction that fortunately subsided. In the other the reaction was so violent that the resulting iridocyclitis necessitated removal of the eye, which was found to have a choroiditis, together with posterior staphyloma, so that it would not have been a favorable case for any kind of intraocular operation. 4. The reasons given above have influenced me against performing the operation, for I would rather operate on an immature cataract and do a subsequent needling operation. 5. I am unable to judge. 6. I can not say.

**T. R. Pooley**, New York: 1. I formerly did, but not now. 2. No. 3. None. 4. It is safer and better to wait, and the operation is easier and safer. 5. Yes. 6. I do not know; I have kept no statistics on this point.

**O. F. Wadsworth**, Boston: 1. I have done so, not often, and not of late years. I presume you refer to massage after evacuation of aqueous. 2. Iritis, with posterior synocha, etc. 4. In part, I think the dangers from the operation at least as great as those which immaturity adds to the ordinary cataract operation. 5. In some instances, yes. 6. No.

**A. A. Hubbell**, Buffalo: 1. Not for eight or ten years. Before that I practiced it considerably. I did a small iridectomy, and then with the elbow of a strabismus hook triturated (kneaded) the lens through the cornea. 2. None whatever. 3. None. 4. Yes, may own experience. I gave it up because the ripening did not always take place, especially when the opacity was nuclear, because the trituration or kneading affected only the anterior portion of the lens, but more particularly because removal of immature cataract without the ripening process gave just as good results. 5. Yes, but no better. 6. Yes.

**C. S. Bull**, New York: 1. I formerly did, but for some years have given it up. 2. None but failure to succeed, and in several instances the manipulation caused partial disappearance of the opacity. 3. This question is practically answered under No. 1. 4. This question is practically answered under No. 2. 5. No. 6. Fully as often.

**O. Dodd**, Chicago: 1. No. 2. No serious results myself, but have seen very serious results from the operations I have witnessed by others. 3. Not at all. 4. In my experience it has been of no benefit, as the lens does not come out more easily or completely than without it. It is necessary to wait some time after operation before extraction can be done, and had rather do extraction and wait after for cortex to clear. 5. Yes, in the few cases I have done. 6. I think so, but my experience is not large enough to say.

**E. E. Holt**, Portland, Maine: 1. No, not in recent years. 2. No. 4. My reason, take it all in all, is that it is better to perform the regular operation. 5. Yes, in the few cases in which it was employed years ago. 6. Not sufficiently to state.

**P. A. Callan**, New York: 1. I formerly did the operation, but not for several years. 2. Yes, iritis. 3. I should rather extract the immature cataract, having made a preliminary iridectomy. 4. I get better results from a preliminary iridectomy, as my results from the ripening operation were not satisfactory. 5. About the same. 6. Very little difference.

**C. J. Kipp**, Newark: 1. Not now. Years ago I did several, but as they failed to hasten the ripening materially, I have given up the operation. 2. No. 5. Yes. 6. Yes.

**H. D. Bruns**, New Orleans: 1. Which operation? I have done iridectomy and trituration without much, if any, effect, often. Tried discission many times, years ago, with too much effect. 2. Senile eyes, on which discission has been performed, do not quiet down readily, and one has usually to do the extraction in an eye not entirely healthy. My experience is that the slightest pathologic condition, sometimes one which we hardly believe to have any importance, militates against perfect success in the extraction of senile cataract and the final result. I would rather take the chances of operation on a very unripe senile cataract, using lavage if necessary, if driven to it by humane motives, than risk discission and subsequent extraction. From trituration after preliminary iridectomy. I am not sure that I have seen any result. I write entirely from my own past experience.

O. A. **Griffin**, Ann Arbor: 1. I did formerly, but rarely now. 2. Yes, an acute glaucoma, but it ended well. 3. When cataract exists in each eye, is partially matured, and the process has become stationary. 4. Have extracted immature senile cataracts in few cases without ripening, and obtained good results. 5. Yes, but not better, as stated above. 6. Have not sufficient data on this point.

A. R. **Baker**, Cleveland: 1. Yes, formerly. 2. Yes, iritis two or three times, and glaucoma once. 3. I would not perform operation, except in patients under 45 years of age. 4. More satisfactory results are obtained by extracting immature cataracts, first making preliminary iridectomy and extracting immature lens, two or three weeks later, with preliminary capsulotomy. 5. No.

M. **Black**, Denver: 1. No. 3. I really can not conceive of any condition which would cause me to subject the patient to this unnecessary operation. 4. I believe the lens of a patient which is sufficiently opaque to demand extraction at all is hard enough to remove without preliminary ripening. If any doubt remains as to the cortical substance being all removed, anterior chamber irrigation should be practiced.

H. M. **Post**, St. Louis: 1. I performed the operation several times fifteen or twenty years ago. I have not done it since. 2. No. 3. I do not now think of any. 4. Under antiseptic precautions I do not hesitate to perform extraction with an iridectomy, as soon as the difficulty in reading is serious. I have had excellent results in such cases.

E. C. **Ellett**, Memphis: 1. I do not do it now, though I have done it a few times. 2. No. 3. I would as soon extract an immature cataract as to do the operation. 4. I regard it as unnecessary. 5 and 6. Too few cases to say.

J. M. **Ray**, Louisville: 1. I did up to the last five or six years. 2. None, except I think that the massage produces adhesions of lens substance to capsule, and therefore the lens sticks and is more difficult to get out of capsule. 3. Only when there is one eye, and if I did a preliminary iridectomy I might massage the lens. 4. As given above, and from experience, I found myself less inclined to the operation, and more inclined to remove a semitransparent lens. 5. I have no statistics on subject at hand. 6. While I have no exact data, I should think just as often.

C. A. **Veasey**, Philadelphia: 1. No. 2. Difficulty in extracting the ripened lens, which is apt to adhere and to require greater pressure. There is more severe reaction. 4. As stated above, difficulty in expelling the lens, because of adherence, more fre-qunt loss of vitreous delivery and more severe inflammatory reaction. 5. No. 6. I have not noticed any difference.

D. S. **Reynolds**, Louisville: 1. I have abandoned all ripening operations as unsatisfactory and unnecessary. Extraction of immature cataract is more satisfactory, because it saves time and avoids the complications of iritis, etc. 2. Yes, iritis frequently; opaque capsule; in two cases, cyclitis. 3. I formerly did it when both eyes were unable to read and neither mature. 4. Yes, as stated above. 5. Sometimes. 6. Yes.

A. **Barkan**, San Francisco: The only operation for ripening cataract done in a normal eye, if slowly developing nuclear cataract, was an iridectomy. The cornea was very gently smoothed out by means of the strabismus hook. Reaction was very great. Iritis and slight cyclitis followed, and the case never came for operation subsequently. I have never since then done a truly ripening operation of immature or senile cataract. The preliminary iridectomy I have done repeatedly, especially when one eye was at stake, and with no results so far as ripening was concerned, but facilitating and rather helping to secure good results when the time for extraction came on the other eye. I am opposed to this measure on the grounds of conservative surgery, and think the massage, if done at all efficiently, is likely to be extended through the lens proper to the surrounding uveal membrane. I would certainly object to these operative proceedings on my own eye.

F. **Park Lewis**, Buffalo: 1. Of late years I have entirely given up the ripening operation. 2. In many cases it did not prove satisfactory. Ripening did not seem to be hastened in some instances; on the other hand, it seemed to retard the process of opacification.

It moreover thickened the capsule and made it more unruly for subsequent management. 3. I doubt if any. 4. The reasons are as given as above, and are wholly based on my own experience. My reasons for not employing artificial ripening are that I believe that with normal salt irrigation or extraction in the capsule it is possible to get better results in the case of an unripe lens than that which follows when the capsule has been thickened by trituration. 5. My impression is that I have. I have not, however, made statistical comparison. 6. More so, with the same qualification as above.

**William Campbell Posey**, Philadelphia: 1. Prior to five years ago I did several ripening operations for cataract, but I have given up the operation. I have found that I secured as good results in operating on immature cataracts without previous ripening, as I did when this operation was performed. 2. In one case, in which the lens was directly triturated, I think I obtained a detachment of the retina, as the tension became much diminished, and I feared for a time that the eye would be lost. Under treatment for detached retina, i. e., rest in bed with a pressure bandage, the eye finally gained its normal tension, the lens was removed and the patient obtained good vision, which has been retained for four or five years. I believe that the procedure of washing the anterior chamber after the removal of an immature lens has done away with the necessity for the preliminary ripening procedure.

**D. T. Vail**, Cincinnati: 1. I have done so a number of times. 2. No, bad results, in some cases the cataracts were not influenced. 3. None. 4. Yes. I find I can extract without, and the ripening is unecessary, also that it is not at all reliable. 5. About the same, but hard to judge; each case is its own rule. 6. Yes, all had to be discissed.

**Flemming Carrow**, Detroit: 1. I never perform a ripening operation in cases of immature senile cataracts. I remove the lens as soon as the patient begins to lose reading ability. I might say that in the last three or four years I always remove the lens when the patient loses reading ability. I do this because in such cases I have a little instrument with which I wash out the anterior chamber. Knowing that in cases in which the lens is immature, there is more or less of the lens débris left. To put it plainly, I always remove the lens, and I always wash out the anterior chamber after removing it. I do this, whether the lens is hard or soft, diabetic or otherwise.

**William Zentmayer**, Philadelphia: 1. No. 4. Because in the exceptional cases in which it might have been indicated I have not hesitated to remove the lens, either after a preliminary iridectomy or with iridectomy at the time of extraction. 5. Not having done the ripening operation, I can make no comparison, but the results after the removal of unripe cataract have been satisfactory.

**H. B. Young**, Burlington, Iowa: 1. Have done it once only. 2. No trouble of any kind. 3. Governed by the needs of immediate vision. 4. With Reik's flushing apparatus, I would about as soon extract the immature cataract. 5. In my one case, quite as good. 6. My patient was from a distance and I did not see him again.

**A. J. Donovan**, Butte, Mont.: 1. No. 2. A few years ago I had a severe reaction, increased tension and had to remove lens. Since then I prefer to do it at once, as I consider the rick to be less. 4. Yes, if the patient consents, I remove cataract as soon as vision is not useful. I always wash out the anterior chamber with boric-acid solution, and so far I have never had a single case in which I had cause to regret it.

**G. C. Savage**, Nashville: 1. No. 2. I have never attempted it. 3. Under no circumstances. 4. For the reason that an immature cataract can be removed easily. 5. I have never done the former. 6. After any operation that does not include the removal of the capsule, the latter, sooner or later, becomes opaque.

**H. B. Ellis**, Los Angeles: 1. I do not. 2. No. 4. Poor results in hands of others—no personal experience.

**W. H. Hulen**, San Francisco: 1. No, I prefer to extract the immature cataract in all the cases that have come to me, and, so far, my experience has been favorable in such cases.

**F. B. Eaton**, San Francisco: 1. No. 3. Under 60 years of age in double cataract (uncomplicated) when vision in each eye was too low for earning a living and for endurance. 4. Rarity of my cases below 60 years and my fear of uveal trouble. They are not formed on my own experience.

**Mark D. Stevenson**, Akron, Ohio: 3. In very immature, uncomplicated cataract in a patient from 30 to 40 years of age, when the vision of each eye is insufficient for the patient's common needs and vocation. 4. I avoid as much as possible the ripening operation for the following reasons: 1. At least two operations requiring opening of the eyeball are required, and of capsulotomy, with attending dangers. 2. If ripening is not performed, only one operation is sometimes needed, and two at most. 3. The danger of glaucoma. 4. Others have told me that the cortical matter is more sticky and is removed with greater difficulty after ripening. Personally, I can not say as to this.

**Leartus Conner**, Detroit: 1. No, as it has not impressed me as helpful, while the extractions of such cataracts remained satisfactory. 2. I never did the operation. 3. I do not know any circumstances. 4. I think that there is less risk in immediate extraction. My results from this operation have been so satisfactory that I have no call for artificial ripening. 5. I never made the comparison. 6. I have no experience.

**J. A. White**, Richmond: 1. Yes, I do this operation both with and without iridectomy—trituration through the cornea. 2. No bad results, except occasionally some iritis. 3. In very slowly developing cataracts, when both eyes are involved, and I do it on one only, and usually only when patient is under 60 years of age. 5. Yes, better. 6. I have not done enough immature extractions to make a fair comparison.

**J. O. McReynolds**, Dallas: 1. I have done so, but I have about abandoned the procedure. 2. None. 3. I do not favor the operation. 4. My experience has been that the operation secures no material advantages, but increases the number of operations. 5. Yes. 6. About the same.

**Chas. A. May**, New York: 1. No. 4. No, I do not resort to the ripening operation, simply because I never hesitate to extract the immature cataract when vision is sufficiently interfered with to demand it, especially since resorting to irrigation of anterior chamber in these cases.

**Lewis H. Taylor**, Wilkesbarre: 1. Practically, no. My experience is so limited with the ripening operation that I can not answer the other questions. I have done no ripening operation except a preliminary iridectomy. 2. No. 3. When a man had not vision enough to perform his work, and needed especially to earn his living. Even then, I think the immature cataract might be operated on, especially with irrigation. 4. It has seemed to me better to wait. I have no adverse opinion based on experience.

**F. T. Rogers**, Providence: 1. I have done it frequently up to three or four years ago, when I became convinced that the immature lens could be safely extracted, and since then I have had no occasion to do the ripening operation, although I frequently do a preliminary iridectomy without disturbing the lens. 2. One case of dislocation of the lens. 3. When the vision was so impaired that the usual avocation could not be pursued, but the peripheral changes were not far enough advanced to promise a successful extraction. 5. Yes, save in one case. 6. I have noticed no marked difference.

**E. E. Holt**, Portland, Me.: 1. I have not had occasion to do it for years. 2. No. 3. After stating all the facts, and the operation was selected by the patient or his friends. 4. I generally prefer to remove the lens direct. 5. Yes. 6. My experience is insufficient to make a statement.

**L Webster Fox**, Philadelphia: 1. I do not. 2. No. 3. Only when the nucleus is translucent or sclerosed, and it becomes imperative to obtain better vision quickly. 4. It is always dangerous to operate on an unripe cataract. The early removal of an unripe cataract leads to a deal of trouble. 5. No. 6. More so, always requires a secondary operation.

**Geo. F. Suker**, Chicago: 1. I have not employed it in the last five years in patients at or over 50. If under this age, and both lenses are in the incipient stage and vision is reduced so as materially to interfere with the comfort and occupation of the patient, then I employ Forster's method; but these cases are rare. 2. I have seen iritis follow, also failure to induce hastening or even actual maturation of the lens. 3. Under no circumstances, if patient is at or beyond 50 years of age. See No. 1. 4. At or beyond 50 the lens is readily delivered, even if not in the so-called mature state. In patients beyond 50, see my answer to Dr. Bulson's[1] questions on same topic presented at the Portland Session of the American Medical Association, 1905. 5. Yes, but ripening means the subjecting of the patient to an extra operation, therefore, another hazard. 6. If the capsule is in size peripherally in a line corresponding to the corneal section, capsular catracts are not so prone to occur. If the anterior chamber is thoroughly irrigated and every effort is made to remove soft substances, capsular cataracts are not more prone to occur than in any other method.

C. H. **Beard**, Chicago: 1. Twelve to eighteen years ago I made a number of operations according to the methods then in vogue. I have not tried any of the later ripening measures, such as the salt irrigation of Jacqs, the hot-air douche of Wolfberg and the rapid method recommended by Bahr at the Lucerne congress. 2. I can not say that I noted any positive ill results. 3. I find no further indications for it, being satisfied with preliminary iridectomy and the subsequent extraction of the lens, mature or immature, as the case may be. 4. Unwillingness to subject the eye to needless surgery and manipulation. My experience with artificial ripening caused me to conclude that the perplexities of the extraction were in no way relieved by it. The cortex, instead of being loosened from the capsule, seemed to be made more apparent and the extraction more difficult. 5. Certainly the results were not appreciably better. 6. Yes.

C. R. **Holmes**, Cincinnati: 1. I did formerly, but do not any more. 2. Never very serious, but some unpleasant results, imperfect ripening requiring a repetition and rupture of the capsule and dislocation of the lens. 4. For the reason given above. 5. I have secured better results by extracting the immature senile cataract without ripening. 6. Not positive as to this point, but as the membrane varies in nearly all cases from a mere film to a dense membrane I needle in nearly all cases, as there is no reason why the transparent media need not be absolutely clear.

R. L. **Randolph**, Baltimore: 1. No. 2. Nothing more than iritis. 3. Have no confidence in the operation. 4. Have operated, as well as I remember, about twenty times, and succeeded in ripening twice. In nearly all the cases had an iritis. 5. In the two cases, yes. 6. Am not prepared to say.

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# SOME IMPORTANT CONSIDERATIONS IN THE EXTRACTION OF CATARACT.*

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Established methods of cataract extraction will be discussed in this paper only sufficiently to draw attention to certain of their important points and to compare them with those which I advocate. Soft or membranous cataracts or such others as some traumatic varieties, which do not require extraction, but needling, removal by capsule punch, or other kind of operation, will not be considered.

When the lens is found to be opaque, judgment should determine, after examination, if it is necessary or wise to operate, and if so by which method. The field of vision should be taken, and this is best done by the use of a candle, or preferably two, whereby the field may be mapped out with tolerable certainty. The tension should always be determined. An examination of the urine sometimes gives suggestive hints as to the cause of the cataract, the presence of retinitis, and probable length of life. Herbert[1] rejects cases in which albuminuria is associated with edema. The general state of health should be inquired into, especially bronchial or asthmatic conditions, whether or not the patient can lie supine for a long time, and the position usually assumed in bed. Some patients can not lie on their backs and provision should be made for others so that they may be supported in bed. It is impossible here to dwell on all the detailed information which should be obtained regarding each patient and the many things that must be taken into consideration in determining the propriety of an operation.

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[1] Herbert: "Cataract Extraction."

Examination into details increases the confidence of the patient, but care should be exercised not to dwell too much on every little defect and thus promote nervousness and anxiety and make the patient refuse an operation, preferring blindness, or the useless treatment of some promising quack. The ophthalmic surgeon, more than any other, should obtain the hearty confidence of these introspective, nervous, blind, old people who are preparing for an operation on their most delicate organ.

I shall not enter into much discussion of the advisability of operation, but with others, e. g., Brudenell Carter[2] (Bulson[3] very fully considers the advisability of operation), think that old patients, if unable to attend to their ordinary business because of uncomplicated cataract (not associated with any special disease), whether it be mature or not, should be operated on without too long waiting, since these patients, formerly active, often quickly decline and deteriorate in mind and body because of the enforced inactivity. This breakdown is especially marked in the cardiovascular system which, in turn, affects the kidneys and other organs with end arteries. A little red reflex or the presence of transparent cortex do not deter me from operating, provided that the vision of neither eye is sufficient for the patient's needs, that the cataract is slowly progressive, that the field of projection is good, and that there is no suspicion of serious intraocular disease, e. g., beginning retinal detachment or the various forms of serious choroidoretinitis. Granting that mild iritis is more common and that an operation for secondary cataract is more often required after operating on immature cataracts, is it not even then better to do so than to keep the patient waiting months and sometimes years? The final results should be as good as after the extraction of mature cataract, and vision is restored much sooner, thus aiding the general health. Having determined that an extraction operation is feasible and advisable, the patient should be impressed with the necessity of as strict antiseptic and aseptic precautions as are possible. He should be made to know that his assistance in keeping quiet and in properly turning the eyes is necessary to obtain a good result;

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[2] Carter: "Lectures on Cataract."

[3] Bulson: THE JOURNAL A. M. A., Sept. 23, 1905.

in short, he must be ready to do his part. Unless exceptionally intelligent, he may not appreciate the importance of going to a hospital instead of having the operation performed in a private house, and the dangers should be fully explained to him.

If chronic inflammation of the conjunctiva is present, treatment should be instituted to cure the discharge before subjecting the patient to the danger of infection after operation. A test bandage may be placed over the eye for several hours and the discharge, if any be present, examined microscopically. If pus is discharged into the eye sac from the lachrymal sac and the diseased condition can not be cured, or time and circumstances will not permit, the puncta may be obliterated by cauterization or the canaliculus closed by a ligature, just before operating, as recommended by Knapp.[4] If time permits, an operation obliterating the lachrimal sac is often justifiable in these cases. Gifford[5] slits the upper tear points and injects some indifferent solution in cases seen several days before operation.

For one week before the operation I have the patient wash the eye by means of an eye bath three times a day with some sterile solution, such as saturated solution of boric acid in distilled water or normal saline solution. Eye baths or eye cups if kept scrupulously clean, being frequently boiled and always thoroughly washed and dried before using, are very serviceable. Patients are shown how to use the eye bath and are also given the following printed instructions:

"The eye bath about one-third full of the solution, should be gently pressed against the closed eyelids while the head is slightly inclined forward. The head is then slowly thrown backward, the lids are opened and closed repeatedly, and the eye bath moved slightly from side to side, during sufficient time to count to 30 or 40, so that the solution may completely wash out the eye sac. The head is then again inclined forward when the eye bath is removed (the eyelids remaining closed for a few moments), and its contents, which should be used for one eye only, thrown away."

By this means the eye sac is mechanically and thoroughly cleansed with less irritation and with a greater degree of comfort than by any other. The bath is also used on the morning of the operation and about one hour before operating, after which a sterile eye pad is fastened by strips of adhesive plaster over the eye. The nose should also be sprayed two or three times before operating with a slightly antiseptic solution. Lippincott[6] suggests spraying the nasal cavities with a 1 to 2000 potassium permanganate solution. On the evening of the second day before the operation a large dose of some cathartic should be prescribed, and in certain cases a large enema given in order that the bowels may be locked for one or two days after operation so as to disturb the patient as little as possible. All the hair on the head should be washed the night before the operation, particularly the eye-brows and eye-lashes. In certain cases I express the contents of the glands and ducts on the edge of the lids by gently stripping these margins between the finger on the skin and a smooth glass rod on the conjunctival surface. Sometimes this should be done on several days and in some cases a mild sterile ointment should be applied. Great care is exercised in preparing the field of operation, and I think only unirritating solutions, such as boric acid, normal saline solution, etc., should be used. The skin surfaces about the eye should be thoroughly cleansed, and the surgeon himself or some skilled assistant should then cleanse the conjunctival sac as thoroughly as possible. This may best be done by pressing the solution from pledgets of cotton, sometimes by gently and carefully wiping the conjunctiva of the lids with the moistened cotton, avoiding the slightest injury to the cornea. The hair and scalp should be covered with either a rubber bath cap or towel which has been kept in an antiseptic solution. Other sterile towels, preferably dry, are laid over the neck and chest of the patient extending to the chin, but not above the mouth, as the patient's breath would then be thrown directly into the eyes.

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[4] Knapp, Norris and Oliver: "System of Diseases of the Eye," vol. iii, p. 896.

[5] Gifford: Trans. A. M. A., 1903, p. 150.

Since micro-organisms (*Streptococcus* and *Staphylococcus pyogenes* and *Pneumococcus*) normally abound in the saliva of both patient and operator, infection from this source should be given consideration. G. Hotta[7] states that infection occurs without fail if the saliva is brought into pocket wounds of the cornea and is likely to occur if there is impeded drainage of the tears from an affection of the lachrymal passages. The patient's and surgeon's mouths may be rinsed out with an antiseptic solution before the commencement of an operation.

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[6] Lippincott: THE JOURNAL A. M. A., 1900, p. 930.

[7] Hotta: Klin. Mon. fuer Aug., 1905, vol. ii, p. 237.

Instead of directing the patient's breath toward his eyes by means of a towel placed over the mouth and nose, which should never be done, I have his breath directed away from the eyeball by a small screen made in the following way: A strip of adhesive three or four inches wide and six or seven inches long is covered with gauze on its adhesive side, with the exception of about one-half an inch of its width along one margin, throughout its entire length. By this upper uncovered margin it is fastened across the bridge of the nose and both cheeks an inch or more below the eyes, so that it hangs down over the nose and mouth and directs the patient's breath and saliva away from his eye. It should next be covered with sterile gauze.

If the operator is suffering from coryza, cough or affections of the mouth, or if compelled to speak much and loudly, as when teaching, Hotta[7] believes a veil of gauze is advisable. Axenfeld, Haab, Mayweg, Blaschek, Kuhnt, Flügge, Eversbusch and Hansell[8] also favor mouth veils. Harold Gifford[5] describes a gauze covering for the nose, mouth, beard and hair, which also prevents dandruff from falling directly on the operative field, as being very essential. The scalp and hair of every surgeon should always be covered by a gauze cap. I have made a simple spectacle-shaped appliance that lies below the surgeon's spectacles, if he wears any, over the bridge of the nose and on the cheeks, and is supported by strong temples over the ears. A strip of gauze about one yard long may be drawn over this frame so that the ends meet below. The lower ends of these strips for a distance of ten or twelve inches are then split by scissors and the two halves, one on each side, tied or fastened by a safety pin behind the neck so that the gauze hangs over the mouth and passes under the chin around the neck. As many layers of the gauze may be used as are thought to be necessary. With this appliance the surgeon's breath will not pass upward into his own eyes or blur his lenses, but pass out to the side, and all saliva or excretions from the nose will be arrested in the gauze and he can still talk and breathe freely.

The confidence of the patient is increased by careful attention to every detail. A little previous instruction

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8. Hansell: Annals of Ophth., April, 1905

as to his own behavior, how to turn the eyes downward and sometimes also a little outward, is very helpful. In particularly nervous individuals I sometimes introduce the speculum in the eye under cocain anesthesia at my office or some time before operation and explain to them how to hold and how to turn the eye up, down, to the right and left, and thus permit them to become accustomed to it. Herbert[1] of India insists on carefully training the patient. Many a blind patient can easily direct the eyes downward toward his own uplifted hand. Sometimes I hold instruments about the patient's face and touch the eye, pretending that I am operating, until the patient being assured that I am nearly through becomes quiet, then I commence to operate. I have never been detected in this ruse.

I usually sterilize my instruments by boiling them from five to ten minutes, those with cutting edges being wrapped in cotton, and then place them in a sterile solution contained in a shallow tray, the bottom of which is covered with a few layers of sterile gauze to keep the instruments from coming in contact with each other.

In addition to about six instillations of 4 per cent. sterile cocain solution, a minute or two between each instillation, the lids remaining closed to prevent drying of the corneal epithelium, I inject a few minims of a sterile adrenalin and cocain solution with a sterilized, aseptic, all metal, solid-plunger, hypodermic syringe under the limbus conjunctivæ where I intend to enter the Graefe knife in commencing the section, and also in the opposite limbus where the point of the knife is expected to exit from the anterior chamber. This adrenalin and cocain solution is prepared by placing a hypodermic tablet of adrenalin and cocain in fifteen minims of distilled water which is boiled for two or three minutes. This gives a sterile solution of approximately 1 per cent. cocain and 1/4500 adrenalin. This assists me in commencing a large conjunctival flap, which I believe should extend three or four mm. beyond every portion of the corneal flap and not merely from eight to ten mm. at its upper margin as made by others, e. g., Clarke.[9] The adrenalin greatly checks bleeding under the flap, which should be folded back on the cornea at once to prevent the blood from being forced into the anterior chamber. I recently learned for the first time that Koller and H.

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[9] Clarke: Opthalmology, July, 1905.

Gifford[10] had made subconjunctival injections of cocain at the limbus, and that Gifford formerly made large conjunctival flaps. In the same paper he states that he abandoned this hypodermic method of using cocain because the artificial edema of the flap prevented ready coaptation, and he also advocates a small conjunctival flap. I have always used the adrenalin and cocain together and find that the flap adheres very readily and strongly, not being edematous. It seems that the trifling disadvantages of this large conjunctival flap, viz., hemorrhage, care of folding it on the cornea when it partially obscures the iris, and rarely filtration edema, are far outbalanced by its great advantages, since it speedily becomes agglutinated to the raw surface on the sclera closing the wound externally and sealing it, and thus aids in the accurate coaptation, and smooth and speedy healing of the scleral and corneal wound margins with lessened postoperative astigmatism, and comparative immunity from after infection, incarceration, or iris prolapse.

The knife is first entered into the temporal conjunctival bleb produced by the subconjunctival injection of the cocain and adrenalin solution three or four mm. or more from the sclerocorneal junction. After passing through the bleb the point of the knife is directed toward the center of the eye so as not to get between the lamellæ of the cornea, and when it has opened the anterior chamber some of the cocain enters and renders the anesthesia more profound. The knife is passed across the chamber and through the opposite corneoscleral junction into the other conjunctival bleb. I then make a large section in the corneoscleral junction, including nearly the upper half of the cornea, with a very large completely-bordering conjunctival flap. A small section strips the cortex from the lens, rendering the delivery of the latter difficult, requiring greater force, entangling the iris, and bruising it and the lips of the incision between which latter cortical débris is likely to be retained, thus giving a starting point for infection.

In some patients with shallow anterior chamber, in order not to scalp the iris, it is better to make a smaller section at the corneoscleral junction than the one described, and to enlarge it to the required dimensions by strong blunt-pointed scissors. If there is a deep anterior chamber the conjunctiva may be raised without the use of the hypodermic at the point of exit of the knife, so as to obtain a conjunctival flap by waiting a moment after the knife has passed through the cornea and sclera, or sometimes by slightly turning the knife so as to permit a slight amount of aqueous to flow out under the conjunctiva (Brudenell Carter[2]). The use of the hypodermic is to be preferred to this method, in which too much aqueous might escape, and the iris, falling over the knife, might be scalped and a portion of it sacrificed. It is easy to get a large conjunctival flap when started correctly with the above-mentioned precautions, if the section lies clearly in the corneoscleral junction and not as usual in the cornea. It should be remembered that in front at this junction the sclera slightly overlaps the cornea, and such sections should include not only a little of the cornea internally, but also some of the sclera externally, and must do the latter in order to have a conjunctival flap. This is not identical with the purely scleral section described by Fuchs.[11]

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[10] Clifford: Am. Jour. Ophth., November, 1904.

In making the incision it is well to have the patient look downward and a little outward so as to give the point of the knife greater freedom of movement without sticking into the inner ends of the lids. Care should also be taken that no portion of the blade which has once touched the lid margin be allowed to enter the section. The cross-bar of the speculum should be well down against the cheek, as in my adjustable speculum.[12] The speculum described by Beard[13] is also excellent, since it can be bent so as to place the cross-bar on the cheek. Each one has much the same old style of solid lid holders which will not catch the corneal section on removal or permit the contents of the glands in the margins of the lids to be deposited on the section. I think that when the section is made in the junction between cornea and sclera, although there is greater hemorrhage, it is to be preferred to one made in the cornea only, for the following reasons:

1. Since there is a good blood supply at the limbus, healing will be more rapid than in the bloodless cornea.
2. A conjunctival flap with all its advantages may be

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[11] Fuchs: "Text-book of Ophthalmology," p. 695.
[12] Stevenson: Ophthalmic Record, April, 1904.
[13] Beard: Ophthalmic Record, January, 1905.

obtained which can not be done in a purely corneal section.

3. A section within the cornea will usually be smaller and therefore scrape more cortex from the lens and will have its margins more severely wounded than will the larger section in the sclerocorneal junction.

4. The more peripheral location of the wound is an advantage in delivering the lens, as it has to turn less on its axis.

5. Tags of capsule, etc., are not so liable to be incarcerated in a peripheral section, since it is farther from the pupillary area and heals much more promptly with less escape of aqueous, being protected by the conjunctival flap. The danger of prolapse of the iris, which on first thought might seem to be increased, is lessened.

6. The less peripheral the incision the higher is the degree of postoperative astigmatism (Majewski[14]).

After instilling another drop of cocain the conjunctival flap, by means of a spatula, should be carefully folded back on the cornea (the larger the flap the more easily this is done and the better it remains) else it would subsequently be in the way and possibly might be cut off. This folding back of the flap on the cornea should be done as soon as possible after the section is completed, as otherwise blood might be forced into the anterior chamber. If there is some hemorrhage from the conjunctiva a few drops of adrenalin should be instilled and nothing further done for a few moments until all the bleeding has ceased.

After telling the patient to expect a little momentary pain and cautioning him quietly and gently to keep looking downward, both eyes open, without any tension or squeezing and to keep his hands open and not set the jaws, I pass an iris forceps, with small teeth only on the lower back edge and not on the end, into the anterior chamber. The forceps grasps the iris a very little beyond the middle of its anterior surface and never at or near the pupillary margin, as is generally advised in all the literature at my command, when any specific instruction is given. The iris is then withdrawn folded on itself, until the pupillary edge lies just outside the corneoscleral incision. By grasping the iris as described its whole width may be withdrawn from the eye with only one-half the traction and correspondingly less pain and tearing of the iris tissue than if it be grasped at or near its pupillary margin. The iris should be pulled no more than is absolutely necessary, so as to wound this delicate nervous structure the least possible and thus reduce pain, exudation and hemorrhage. For example, it can be readily understood that if the iris is four mm. in width and it be grasped at the pupillary margin, this margin would have to be drawn eight mm. from its original position in order to have the whole width of the iris outside the incision. If the iris be grasped at the middle as described the forceps would need to be withdrawn only four mm. and the pupillary margin would be stretched only four mm. from its original position instead of eight mm. as in the other method, one-half as far, only one-half as much traction, and less than one-half as much tearing and injury. By means of a sharp pair of strabismus or other scissors held alongside and parallel to the forceps, the folded iris tissue is cut through with one snip in the vertical meridian from pupillary edge to outer periphery, a true sphincterotomy and iridotomy, but not an iridectomy, since no iris tissue is removed. Properly speaking, sphincterotomy means division of the sphincter only, but I prefer to use it in this wider sense, since the term iridotomy, although more proper, has been already used for a different operation and would be likely to give rise to confusion. I have been performing sphincterotomy for some time, and until the preparation of this paper believed it to be a new method. I recently found that Williams[15] in 1881 and Meyer[16] in 1887 incidentally referred to it, each, however, in only a part of one sentence.

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[14] **Majewski:** Annals d'Oculistique, vol. cxxvi, 99.

I think the general concensus of opinion, even though contrary to that of many distinguished surgeons, is that a combined operation is usually preferable to simple extraction, especially in complicated cataracts or those with posterior synechiæ or rigid pupils, in that there is less danger of subsequent iris prolapse or incarceration, less tearing of the iris tissue in general, and less retention of cortical matter because of less stripping of the lens by the divided sphincter; and also because less pressure is required to expel the lens through the enlarged pupil.

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15. Williams: "Diseases of the Eye."
16. Meyer: "Diseases of the Eye."

Preliminary iridectomy or sphincterectomy seems to give excellent results, but it exposes the patient to the dangers of infection through two operations requiring the opening of the eyeball. It does not seem that the facility of removal is increased sufficiently to warrant the extra risk, loss of time, expense and trouble to the patient. Objections urged against the combined operation are that it mutilates the iris and furnishes a focus for infection, that the light entering the larger pupil dazzles the patient and is not so perfectly focused as that passing through a small pupil. I do not wish, however, to thrust myself out on this common battlefield.

Dividing the sphincter and width of the iris before attempting delivery of the lens merits consideration for the following reasons:

1. If they are completely divided less resistance will be offered by the sphincter and iris to prevent the escape of the lens from behind them, so that less pressure will be required to deliver the lens and consequently less tension is placed on the suspensory ligament, and there is less tendency to prolapse of vitreous.

2. Since the iris is cut completely through, the anterior support to the upper margin of the lens opposite the section is greatly reduced, so that the upper margin may be more readily tilted forward and pass out of the eye without so much chance of turning over or other accidents.

3. Because of the large opening through which the lens may pass, there will not be nearly as much stretching or rupturing of the other portions of the pupillary margin and iris tissue, and not as much subsequent exudation, even though there might be more exudate and hemorrhage just after making the incision in the iris. At this time, however, blood or exudate can always be washed out of the eye by the irrigator. The more tears or ruptures in the pupillary margin of the iris, the greater the number of posterior synechiæ which subsequently form between the torn iris and capsule.

4. The margins of the larger opening through which the lens may be passed do not strip the cortical matter from the lens mass and retain it as does an undivided sphincter. The coloboma furnishes a sluice way through which the soft cortical matter may be readily removed (Bulson[8]).

5. Thickened, inelastic, flabby irides unless incised,

are much stretched and torn, and are more prone to remain outside the section, or later to prolapse because they are pressed into a funnel shape during the exit of the lens.

6. Free division of the iris establishes easy and continuous passage for the fluid between the anterior and posterior chambers, even to the periphery. When the iris and sphincter are undivided the fluid is said to collect in the posterior chamber, especially behind the peripheral portion of the iris, and if the corneal section should suddenly open because of some sudden pressure of the eye muscles or other cause, e. g., coughing in chronic bronchitis, this pent up fluid is liable to prolapse the unsupported iris in its rush to escape from the eyeball.

7. It is easier to replace the divided iris within the section at the time of operation (a) because of the free connection between the anterior and posterior chambers; (b) the sphincter divided in only one place is stronger than when torn in many; (c) the body of the iris and sphincter is not thickened so much by exudation and hemorrhage; (d) the elasticity of the structure has not been destroyed to the same extent.

8. There can not be as strong a tendency to the development of postoperative glaucoma.

I think that iridotomy or sphincterotomy is preferable to iridectomy or sphincterectomy for the following reasons:

1. The operation is easier and simpler to perform, consisting of one simple straight snip of the scissors held at right angles to the surface of the cornea.

2. The total length of the cut iris is less on account of the long U-shape of the iridectomy incision from which there is greater exudation and hemorrhage. The cut going directly to the periphery is also in a better position within the eye than a mere sphincterectomy.

3. Iridectomies as done before cataract extraction are usually not peripheral, and the peripheral portion of the iris tends to retain the lens, and afterward the fluid, behind it. When the incision extends through the width of the iris the lens and fluid are not retained behind it.

4. The coloboma is much narrower, a mere slit peripherally, than in an iridectomy and being altogether or almost covered by the upper lid, the patient is not sub-

sequently dazzled so much by the light as after an iridectomy which leaves a broader coloboma.

5. The shape and size of the coloboma, particularly the sharp edges at the pupillary margins, are well known, so that when the toilet of the eye is made it can be readily seen when the iris is completely within the eye. It is not always possible to know the exact size and shape of the piece of iris removed in an iridectomy, thus making it a little more difficult to know when the iris is properly straightened out within the eye.

Macnamara[17] in 1882 advocated the excision of a small peripheral piece of iris leaving the sphincter intact. Dr. Taylor of Nottingham removed a sufficiently large peripheral piece of iris to permit the egress of the lens. H. B. Chandler[18] reports 312 cases of cataract extraction with a small peripheral buttonhole in the iris. This latter method is no doubt better than a simple extraction, as the fluid can more readily pass from one chamber to another, and will not be so liable to dam up behind the iris and to cause its prolapse on sudden escape of fluid through the section. Since the buttonhole (if not made too large) will be covered by the upper lid after operation, there will be no apparent deformity of the iris due to the artificial coloboma as after iridectomy or sphincterotomy. I think, however, that sphincterotomy is to be preferred to this small peripheral buttonhole in the iris for the following reasons:

1. Without any personal experience with the latter, I should think it somewhat more difficult to do, even if the iris would need to be withdrawn less, since care would have to be exercised, not to make the opening too large and so have the lens pass through it instead of through the pupil, or such that it would catch and hold the edge of the lens. Some operators make the buttonhole after the expulsion of the lens.

2. There would not be such free communication between the chambers, and correspondingly greater danger of subsequent iris prolapse.

3. The sphincter being intact, this operation is open to most of the objections raised against the simple operation, e. g., stripping of the cortical substance from the lens, stretching and tearing of the sphincter and adjacent iris, increased hemorrhage, exudation and thicken-

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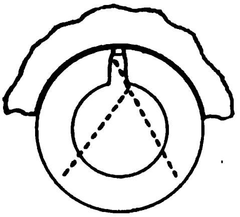
[17] **Macnamara**: "Diseases of the Eye."

[18] **Chandler**: Archives of Ophthalmology, January, 1904.

ing, greater force required to expel the lens, with consequent greater danger to the suspensory ligament, prolapse of vitreous, etc.

The next step in the operation is to perform a simple but efficient capsulotomy. The varieties of capsulotomy described are legion, but most of them are more or less impracticable because difficult, and some are even impossible to perform. It is more or less difficult to make horizontal incisions in the capsule and considerable dexterity is required to make some of the combinations of incisions described. A few operators, DeWecker, Eugene Smith,[19] remove a portion of the anterior capsule by means of capsule forceps. Knapp[20] states that dislocation of the lens with prolapse of the vitreous and its consequences are not unlikely accidents in the removal of the anterior capsule. Others follow Pagenstecher's method and remove the lens within the capsule. The anterior capsule may be so incised without removal that it will not obstruct the pupillary area or have anything to do with secondary cataract in this area, although, as in every method, some cortical matter is retained in the peripheral areas. Secondary cataract in the peripheral area is sometimes useful by partially blocking the entrance of light into the coloboma. Of course the posterior capsule is the one chiefly concerned in the production of secondary cataract in the pupillary area; deposits in the form of "pupillary membranes" sometimes form on the front of this capsule. A good sharp cystotome



This diagram represents position and size of the conjunctival flap, position of section in corneoscleral junction, and narrow coloboma after sphincterotomy, the dotted lines representing the two incisions in the capsule; the angular flaps, which curl up, lie on either side of the short dotted line; the lower flap having the sharper angle curls more out of the way than the other.

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[19] Smith: THE JOURNAL A. M. A., Sept. 26, 1891; also Am. Jour. Ophth., November, 1904.

[20] Knapp: Am. Jour. Ophth., September, 1905.

is necessary so that but two cuts will be needed in making the two incisions. More are unnecessary and will even be harmful, since then small strips of capsule are liable to lie in the corneal section preventing prompt healing, and therefore exposing the eye to greater danger of infection. The cystotome I use has no sharp points to catch anything; it has a blunt end so as not to injure the iris when pushed up under it, and a cutting knife edge that will cut either way and may be easily sharpened. The instrument is passed with its cutting edge backward, across the anterior chamber and for some distance under the distal portion of the iris, toward either side, usually the nasal. One straight cut is then made across the whole lens passing through the pupillary area about 1 mm. from the pupillary edge of the iris and into the coloboma made by the sphincterotomy so that this incision extends as nearly as possible throughout the whole anterior capsule, and not merely in its pupillary portion. If the peripheral portions which are thinnest are not cut, cortical masses are more liable to be retained within the capsule, and greater force is required to remove the lens from its capsule. The cystotome is then again passed under the distal portion of the iris, but on a different side from the one chosen before, and a second cut is made passing more nearly to the center of the pupillary space, and meeting the first incision at the beginning of the coloboma or proximal pupillary margin. This method of doing a capsulotomy is worthy of attention for the following reasons:

1. It is simple and easy to do.

2. There are no strips or tags of capsule that can possibly get into the corneal wound, especially if the incisions are so large and peripheral that the capsule will not be torn by the exit of the lens. Promiscuous and extensive laceration of the capsule is harmful because tags of capsule are sure to lie in the section and retard or prevent healing, causing an uneven irritable scar which may help later to cause iritis, especially as there will also be more posterior synechiæ.

3. The flaps of capsule will tend to roll up out of the pupillary area. The sharper the angle of the flap the farther it will roll out of the way; this has been considered in locating the position of the incisions. The thin sharp flap from below will roll considerably downward

out of the way. The lateral flap will roll somewhat to the side and out of the pupillary area and the largest portion on the other side of the first straight incision will also retract slightly out of this area (some might prefer to divide this last portion by another oblique and similar incision). While all the flaps of capsule will retract from the pupillary area, none of them are so situated that they can get into the corneal wound.

After capsulotomy is completed the next step is to expel the lens. This is done in the usual fashion by making pressure toward the center of the eye by a spoon or spatula over the lower limbus, while another spatula very gently depresses the sclera at the corneoscleral junction. After the lens has passed one-half way through the section the lower spatula should follow it with less pressure on the eyeball. A very little stroking of the cornea may be indulged in to remove some of the larger particles of the cortical substance, but with many operators, I believe, it is usually better to use, with proper precautions, intraocular irrigation in removing blood, exudates, or cortical substance from the interior of the eye, and for this purpose, I prefer to use gently a slightly warm sterile boric acid or normal saline solution in a properly constructed gravity syringe. Great care should be used to prevent the retention of quantities of solutions within the eye sac.

This question of irrigation or lavage has been fully dealt with in many excellent papers by Reik,[21] Beard,[22] Bulson,[3] and Lippincott,[23] and does not need further commendation or elucidation here. I think that after its use, which should not be continued too long, capsular opacities are less frequent or at least less dense, so that secondary operations are not so frequently necessary. By its use, except in some sclerotic cases with no lens débris when it is not required, we can obtain a more nearly perfect technic and secure striking, often brilliant results. The patient is usually much encouraged by the better vision after syringing out the lenticular débris, and is stimulated to do his part toward obtaining a happy result. After the use of the irrigator the iris seems to contract better and sometimes assumes its proper position without any manipulation. McKeown claims that the tendency to subsequent prolapse of the iris is lessen-

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21. Reik: Annals of Ophth., July, 1903.
22. Beard: Ophthalmic Record, April, 1905.
23. Lippincott: Ophthalmology, January, 1906.

ed, and this should be expected since retained cortical masses by their swelling tend to increase tension and possibly prevent smooth healing and coaptation of the wound margins. Since there is more complete elimination of débris and speedier closure of the sclerocorneal section, and since if micro-organisms have entered the eyeball, many of them will be washed out, sometimes so diminishing their number as to render them harmless, inflammation and infection are less liable to result. When the anterior chamber remains empty and the cornea shrunken, the corneal dome may be re-established and the lips of the incision brought into correct apposition, aiding rapid healing and restoring corneal curvature. It should sometimes be used to remove blood from the eye during the operation as after sphincterotomy and before capsulotomy is done.

After irrigation the toilet of the eye is completed. If the iris is not in its proper position as shown by a sharply defined coloboma, especially at its pupillary corners, a spatula should be used to place it in a correct position and to reduce the tags of capsule lying in the wound. I have always been able to do this without any difficulty, but it is possible that rarely a case might be found in which an iridectomy might be necessary if the iris could not be properly replaced within the eye. Next after a little mild irrigation of the incision, the conjunctival flap is gently folded back into position by a spatula, and smoothed out. Its surfaces are usually sticky and it readily and strongly adheres, undoubtedly assisting in the accurate coaptation of the lips of the incision which, therefore, heal more quickly and make infection correspondingly less likely. Dr. C. F. Clarke[9] claims that a conjunctival flap diminishes the amount of subsequent astigmatism. Earnest F. Maddox[24] advocates suturing the conjunctival flap. I doubt the propriety of prolonging the operation by this procedure, not only because the flap adheres so strongly without suturing, but also because, as Melville Black[25] has pointed out, the eye must be prepared, anesthetized, and a speculum introduced in order to remove the sutures which also beget infection. Kalt proposed a corneal stitch inserted like a Lembert intestinal suture, before operation, the central loop being long and drawn out of the way during the operation, after the completion of which the ends are drawn taut and tied.

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[24] Maddox: Ophthalmoscope, November, 1904.

[25] Black: Ophthalmic Record, February, 1905.

Finally, I usually instil one drop of one-half per cent. of eserin sulphate into the eye, as this amount will not irritate and will cause the sphincter to contract slightly and for some time, so that the iris will be less likely to prolapse. Fuchs,[11] Gibbons,[26] Jackson,[27] and many other authorities state that eserin lessens the danger of iris prolapse. Before the pupil dilates again some remnants of cortex or capsule in the pupillary space may become attached to the iris, and when the pupil dilates be drawn from the central pupillary area. A dry, sterile, double eye pad, made by sandwiching a little sterile absorbent cotton between a few layers of sterile gauze, is then lightly fastened usually over both eyes by strips of adhesive, which latter are not so easily disturbed during restlessness as a roller bandage, and which may be cut in removing the pad for the first few days.

In order that no pressure may be made on the eyelid of the eye operated on, the strips are placed over the margins of the eye pad and do not directly overlie this eyeball. For the first day or so they are tightly placed over the pad covering the eye not operated on, making some pressure and thus tending to prevent the opening of the eyelids. A dressing on both eyes sometimes causes mental depression or excitement in old people. For the first few days it is well to cover the eyes for protection with some style of ocular mask or shield, such as Ring's mask, being careful not to make thereby any pressure on the dressing or lids. I have not had any experience with the so-called open method of treating these cases advocated by Fuchs and other distinguished ophthalmologists, especially those abroad, who claim smoother and speedier healing with less frequent hernia of the iris.

Undoubtedly, postoperative astigmatism is influenced by a conjunctival flap, the size and location of the section, the sharpness of the knife, or by anything which influences healing, e. g., prolapse or incarceration of the iris, swelling or cortical débris, presence of capsule tags in the wound, muscular action of the lids and eye muscles, and especially by any pressure made by the lids on the eyeball due to the tension of the lids, and particularly that due to pressure from dressings and bandages. The pressure of the lids can not be diminished unless possibly by antispasmodics, but care can be exercised that little or no pressure is made on them. It can be readily understood, for example, that if the section lies in the upper corneoscleral junction, any pressure on the cornea would make the upper flap of the cornea slide upward, overriding the adjacent sclera. This would make the vertical meridian less curved, not only because the cornea in this meridian has become flattened but also because the upper edge of the cornea has been displaced forward on the sclera.

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[26] Gibbons: "The Eye, Its Refraction and Diseases."
[27] Jackson: Philadelphia Med. Jour., May 11, 1901.

The cornea being a stiff structure, if it lengthens in one direction it must necessarily shorten in another, and this latter is what takes place in the horizontal meridian. Also the pressure made on the sclera, which projects forward in the rounding shape of the globe, pushes it backward and brings those anterior portions in the horizontal meridian closer together. Thus the curvature in the horizontal meridian is increased. Pressure on the sclera in the vertical meridian affects the limbus in this meridian exactly as in the horizontal, but the cornea and sclera not being joined together, the sclera merely slips under the cornea and does not pull the corneal margin with it as it does in the horizontal. The flattening in the vertical and increase of curvature in the horizontal meridian, are exactly what takes place after section of the eyeball above, and I think the chief cause is the degree of pressure made by the lids and by different dressings, which latter should be dispensed with at the earliest possible moment consistent with safety. The axis of the correcting cylinder is usually nearly parallel to a line joining the points of puncture and counterpuncture.

## AFTER TREATMENT.

The patient is gently conveyed (carried) to his bed with as little muscular effort on his part as possible. The eye is inspected at the end of twenty-four hours and redressed with usually a single eye pad. This is done each day as long as necessary; the time varies from two or three days to a week or longer. In making these dressings I use only sterile normal saline or boric acid solutions, and never instill any collyria unless specifically indicated, as atropin in iritis, a mild form of which is nearly always present. After the use of a few drops of cocain several operators (Bulson[3]) when the wound has been securely closed for five or more days, instill three or four times a day for a period of four days, first a 5 per cent. and later a stronger solution of dionin, claiming that it increases the effect of atropin, assists in the treatment of iritis, and promotes the absorption of exudates in those cases which are at all affected by the drug. I have several times used a 5 per cent. solution of dionin as early as the third day without doing any harm, but am unable to state whether or not it was of any value.

The quiet of the patient for the first day or two is especially important. All physical exertion, coughing, vomiting, and hiccoughing should be guarded against. The patient should be made as comfortable as possible, should be informed about his surroundings and impressed with the necessity of quiet. For one day it is best, if possible, to have the patient lie quietly on his back or on the side opposite the eye operated on, without turning, and to permit movement of the arms and legs only. When necessary, the head may be made comfortable by the nurse, and after the first day the patient may turn in bed, if assisted by the nurse. I advise fluid or soft diet for at least two days, locked bowels for one or two days, and afterward, if necessary to prevent straining at stool, the use of mild laxatives and enemata. To reduce the discomfort following the normal amount of reaction and to diminish the pressure of the lids on the eyeball, I think it is well when not contraindicated for some particular reason and when it has been used previously without evil results, to give a hypodermic injection of morphia sulphate 1/8 or 1/4 gr. one hour before operating, which may be repeated every 3 or 4 hours if considerable discomfort continues. Dr. Eugene Smith[28] advises morphin hypodermically immediately after the operation because of its sedative and myotic action. The first night, if the patient is restless and can not sleep, a dose of some hypnotic may be given at bedtime. After explaining the reasons for it, it is sometimes advisable to tie the patient's hands to the foot of the bed by long strings, strong enough to wake him if any effort is made to reach the face, but not so strong as to frighten him

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28. Smith: Knapp's Archives, 1894, p. 85; also, Am. Jour. Ophth., November, 1904.

by making him wonder what he would do in an emergency, such as fire. A simple way is to fasten the sleeves of the night gown to the bed clothes by small safety pins.

In conclusion, I wish to direct attention to the necessity of thorough examination and preparation of the patient, to the screens for the patient's and operators' breath and saliva, to the large, completely bordering conjunctival flap which is easily folded on the cornea, the method of obtaining it, the position and size of the sclerocorneal incision, where to grasp the iris when withdrawing it, the sphincterotomy and its advantages, the simple but efficient capsulotomy, the necessity of avoiding pressure on the lids and eyeball by the dressing, and the simple after treatment.

CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# CATARACT EXTRACTION WITH MODIFIED IRIDOTOMY.*

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The following operation seems to possess advantages not offered by any other method of cataract extraction. While thus far it has been performed in only a few cases, it has given satisfactory results in all. More extended experience with it may, of course, bring to light unforeseen objections, but this is not anticipated.

## THE OPERATION.

The corneal incision is made in the usual manner, probably best at the limbus. The iris is then grasped with the iris forceps as near its root as possible and a small bit of tissue excised with scissors so as to leave a small hole in it (Fig. 1). The iris will immediately return to the anterior chamber of its own accord. De Wecker's small iris scissors, preferably with blunt pointed blades (Noyes' scissors will probably serve as well), are then introduced through the corneal incision, gently opened, and one blade passed downward through the hole in the iris until it projects below the pupilary margin. The blades are then quickly closed, thus making a clean cut through the iris to the pupil. Owing to the mydriasis produced by the cocain, the edges of the incision will separate, usually at once, as widely as after an ordinary iridectomy (Fig. 2). If, however, the iris is pressed against the cornea by the lens, this may not happen until after the lens has been extracted. The lens capsule may now be opened with the cystotome or capsule forceps and the lens expressed in the usual way, or the latter may be extracted in its capsule. In making the toilette of the wound care should be taken, as after an iridectomy, to free the pillars of the coloboma from the incision. It is probably best to instil atropin immediately after the operation, since this enlarges the coloboma and thus lessens the danger of iris prolapse.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

### ITS ADVANTAGES.

This operation offers the advantages of both the simple and combined operations without their disadvantages. The lens is removed with the same ease as in the combined operation, the danger of iris prolapse is minimized, and cortical matter can be expressed with even greater facility than after an iridectomy. Moreover, the modified iridotomy requires no such rough handling of the iris and causes no such pain as iridectomy, while it is superior to the latter in its cosmetic and optical results. The excision of iris tissue is made where it will be most effective in preventing iris prolapse and at the same time do the least damage from an optical standpoint. In the case of iridectomy, a large section of the

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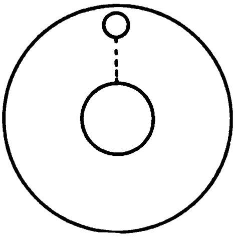

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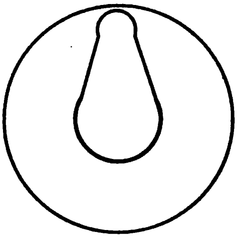

sphincter muscle is always removed so that the reaction of the pupil to light is necessarily much impaired, whereas in this operation the sphincter muscle is simply incised and the pupillary reactions less interfered with. For this reason, as well as on account of the narrow coloboma finally obtained, the dazzling on exposure to bright light often complained of after iridectomy is after this method notably absent. The optical results are, in fact, practically as good as after the simple extraction or the Chandler buttonhole operation.

Objection may be raised to the introduction of an additional instrument into the eye. It would seem, however, that the danger of infection or traumatic inflammation must be less from the introduction of a sterile instrument into the anterior chamber than from the trauma to which the iris is subjected in ordinary iridectomy.

There are two questions in connection with the operation which probably can be answered only after further experience with it. One is the question as to the best situation for the corneal incision, and the other as to the proper size of the hole in the iris. I have always made the incision at the limbus, because this must unquestionably give the best optical results. An incision here, however, is apt to be attended with considerable bleeding, which, with the conjunctival flap, may obstruct the view and thus render the operation more difficult. In regard to the size of the hole in the iris, I have made it as small as possible, but the danger of iris prolapse would no doubt be still further reduced if it were made comparatively large. In any case it should not, of course, be made so large as to remain uncovered by the upper lid.

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# THE USE OF THE SECONDARY CATARACT KNIFE.*

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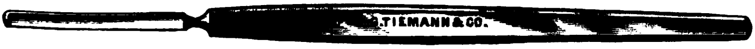
The use of a knife for enlarging and completing the section in cataract extraction was popular with Mackenzie when he published his "Treatise on the Eye" some fifty years ago. I can not find that the subject has received any attention during recent years except in an article of mine[1] in which I failed to credit Mackenzie with his work because I was unaware of it until Dr. Oscar Wilkinson called my attention to it.



It is not my intention to claim any priority in the use of the secondary knife, notwithstanding my knife differs somewhat from any before in use, as well as does my method of using it.

This knife was made for me by Tiemann and has served me so well that I have found no reason for modifying it in any way. I should now feel that my armamentarium was incomplete without it, hence it is always laid out with my other instruments when preparing to do a cataract extraction. If the section is satisfactory in

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**[1] Ophthalmic Record, February, 1904.**

every way it is not needed, but if the section is not large enough or if the iris falls in front of the knife before the section is completed it is invaluable. I feel sure that I have materially improved my cosmetic results since I have been using it.

Despite all our efforts to the contrary, the iris does sometimes fall in front of the knife. To go right on with the section either results in mutilating the iris or completing the section entirely in the cornea. Those who prefer a corneal section rarely need the secondary knife. Those who prefer to complete the section at the corneal margin or in the conjunctiva will find this knife will enable them to follow their inclinations in the matter.

If the anterior chamber is evacuated by the patient making a sudden movement before the counterpuncture has been made, the knife is withdrawn and the probe point of the secondary knife introduced through the wound into the anterior chamber to a point at about its summit, when it will be found that the section can be made with ease by cutting, with but little sawing movement, at the same time extending the point of the knife around the anterior chamber at the base of the iris until the section is large enough for the removal of the lens.

If, after puncture and counterpuncture, the iris falls in front of the knife, withdraw the knife, remove the speculum and wait a few moments until a little aqueous has formed in the anterior chamber, then replace the speculum and fixation forceps and introduce the point of the secondary knife into the anterior chamber, working over the iris to the summit of the chamber and thence downward, pushing the iris back of the knife until the point passes through the counterpuncture. It will now be found that the iris is held taut by the knife and that the margin of the pupil is back of the knife, and by making a direct traction cut without sawing movements the section can be completed at the corneal margin or in the conjunctiva without mutilation of the iris.

If it is found on pressure and counter pressure that the section is too small for the escape of the lens without unduly bruising the iris it is a very simple matter to enlarge the angles of the wound with the secondary knife.

In a successful cataract extraction obstacles are promptly met and overcome and the operation is completed in the manner planned. Too small a wound demands that it be enlarged or that an iridectomy be performed. A mutilated iris evidences a partial failure, from a cosmetic standpoint surely, and possibly from a visual standpoint as well. Evacuation of the anterior chamber before the counterpuncture is made generally means that the operation should be postponed. I have never yet failed to overcome successfully the obstacles mentioned by the use of the secondary knife. I feel sure that if it is always laid out with the instruments for cataract extraction it will not be long until use is found for it. After once having been used I believe it will become indispensable.

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# THE TREATMENT OF SIMPLE CHRONIC GLAUCOMA BY MIOTICS.*

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PHILADELPHIA.

It is the object of this paper to extol the action of miotics in the treatment of simple chronic or non-inflammatory glaucoma, to call attention to the very satisfactory results which attend the use of these drugs in this class of cases, and to urge their more intelligent and persistent administration; for while eserin and pilocarpin have been employed by ophthalmologists for 25 years or more for their miotic action in glaucoma, they have always been regarded as of secondary value to some form of operative procedure, being used either as adjuvants to iridectomy, both before and after operation, for the purpose of decreasing intraocular tension, or as substitutes for operation in advanced cases where iridectomy is contraindicated.

By most authorities operation has been and is still considered to be the only cure for glaucoma, and while the results of operation are known to be less favorable in simple chronic glaucoma than those obtained in other forms of this disease, yet it is almost universally conceded that even in this type iridectomy gives a better chance for retaining vision than any other form of treatment. I use the term "universally conceded," for I believe that the profession generally has adopted the views of such investigators as Nettleship, Bull, Priestley Smith, Knapp, Collins and Gruening, all of whom recommend early operation in the simple chronic as well as the congestive forms of glaucoma.

Although this advice has been accepted by the majority, it is probable that many hesitate to follow the counsel of these distinguished observers in all instances and prefer to treat many of their cases of simple chronic glaucoma in a less radical manner. When the average ophthalmologist considers the very slow progress of the disease and weighs the chances which iridectomy gives for retaining vision with the positive disadvantages which so frequently accompany the operation, and when he considers the liability of error in confusing glaucoma with optic atrophy, with excavation, and the needless risk of blindness to which patients with this latter disease would be subjected by iridectomy, it is not remarkable that the day of operation is often postponed and that recourse is had to measures which, though they may be regarded as being of less value, are never harmful.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

Is there positive evidence, however, that miotics are of less value than iridectomy in the treatment of chronic glaucoma? Have statistics ever been compiled of groups of cases, the one treated by miotics and the other by operation, which prove this assertion and indicate the superiority of iridectomy over these drugs? So far as I am aware, no statistical study of any large series of cases of chronic glaucoma treated with miotics has ever been made, with the exception of that compiled by Dr. William Zentmayer and myself in 1895. At that time the histories of 167 cases of chronic glaucoma were collected from the services of the late Dr. William F. Norris and Dr. C. A. Oliver at the Wills Eye Hospital, and from these records deductions were drawn which were thought to be fairly conclusive regarding many phases of the disease, including the results of different methods of treatment. Many of these cases had been observed over a very protracted period, and while the miotics which were employed were doubtless but indifferently administered in many instances, and carelessly applied, so that the full advantage which might have been gained from this form of treatment was not obtained in any of the cases, nevertheless an opportunity was afforded of comparing the prolonged action of these drugs with the results of iridectomy, which no other series of observations gives. For the conclusions of Nettleship and those of the other authorities already referred to were based merely on the results of iridectomy, and are of value only as they indicate the manner in which operative procedure influences the progress of glaucoma, and do not present any basis of comparison with cases treated by miotics.

As a result of our studies Dr. Zentmayer and I concluded that "the effect of the administration of eserin and of the performance of iridectomy in checking the course of the disease is proportionately the same in the treatment of simple chronic glaucoma. As operative procedures are always to be deprecated when other means are equally valuable, eserin should be employed in all cases of the disease. If at the end of a month the extent of the field has diminished, iridectomy should be resorted to, as there will be nothing further to expect from the action of the drug. If at the end of that time, however, an improvement is noted, as evidenced by a study of the field, the drug should be continued, as there is reason to expect that a beneficial action will be exerted for ten months on the extent of the field and fifteen months on the visual acuity. After iridectomy is performed there is ground to believe that the course of the disease will be checked for a period of eighteen months in 50 per cent. of the cases.

"Eserin is powerless in 20 per cent., iridectomy in 10 per cent. of the cases. So that 10 per cent. of all cases of simple glaucoma will not be benefited despite all therapeutic measures that may be employed. Both iridectomy and eserin exert a greater influence over central vision than they do on the extent of the visual field. This is seen in the greater percentage of cases in which vision was improved, as well as in the length of time in which it remained conserved.

"The intraocular tension was more benefited by both methods of treatment than any of the other symptoms, for eserin lessened its degree in all but 20 per cent. and iridectomy in all but 10 per cent. of the cases."[1]

In estimating the value of these conclusions it should be borne in mind that they were drawn from a study of dispensary patients and that many of these were under treatment at a time when the manner of administering miotics to the best advantage was not thoroughly understood. From observations which I have made on a very considerable number of cases, both in private and dispensary service, since the publication of the report, ten years ago, I am convinced that were it possible to compare an equal number of cases which had been subjected to the action of miotics properly administered over a similar period, the comparative merits of miotics and iridectomy would be shown to be far greater in favor of the former. Unfortunately, I am not in a position to make such a study, or to state in exact terms what such ratio of comparison would be, for I have not as yet at my command a sufficiently large number of cases which have been followed over a long enough term of years. The difficulty of collecting a large number of cases of chronic simple glaucoma is very great. The disease is comparatively uncommon, and since as a rule it affects those who are advanced in years, death often ensues before the observation can be extended over many years, even when the subjects of the disease remain constant in their attendance on one surgeon. Though lacking statistical evidence to support them, I venture to express my convictions at this time, for I believe that recent utterances by ophthalmologists of note have tended to discourage the use of miotics, so that many who are beginning their ophthalmologic career and others who have but little opportunity for clinical observation have come to regard them as altogether valueless. When no less an authority than Berry asserts that "altogether I believe miotics to be practically useless in chronic glaucoma," and such a careful observer as Cheyney states that in chronic glaucoma "loss of sight without operation is. of course, inevitable," it seems time if one has been assured of the value of miotics to state his convictions and to give whatever testimony he can in their favor.

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[1] Wills Eye Hospital reports, vol. 1, No. 1.

To elucidate the subject, I consider the subject under the following heads: 1. Beginning cases. 2. Advanced cases. 3. Pronounced glaucoma in one eye, the other being unaffected, or with only a glaucomatous tendency.

## I. BEGINNING CASES.

I designate as beginning cases those which have possessed the tendency to glaucoma for a number of months or years and are now manifesting some positive signs of the disease, the tension being, perhaps, more or less elevated, the cupping demonstrable, or some restriction or scotoma having appeared in the visual field.

It is at this stage that the authorities and the books say operate, for they contend that the best results follow operations which are done at this time, asserting that the longer operation is delayed after the diagnosis of chronic glaucoma is once confirmed the less favorable will be the results. They acknowledge that the operation will not control the glacomatous process in all cases and that in some it will accelerate the course of the disease. They do not ignore that even in the most favorable cases there will be certain optical disadvantages resulting from the iridectomy, such as astigmatism and aberration, that the transparency of the lens will suffer in not a small proportion of cases, and that some eyes will be lost from infection. Despite all this, the advocates of iridectomy say operate, for they claim that there is no other alternative, that there is no other treatment, that eserin can not be relied on, that it can not control the disease and that blindness is inevitable.

These are the expressed views of some of the ablest ophthalmologists in the world, and they no doubt express their convictions, but do these surgeons or does any member of this section strenuously and conscientiously follow this advice? Is iridectomy insisted on and urged in every case of chronic glaucoma when once the diagnosis is confirmed? I am convinced that it is not, and that, though operation is advised in many cases, it is done in such a half-hearted manner and the prognosis is guarded with such an unfavorable outlook that the patient would be rash indeed who would decide to submit his eye to it. Under such circumstances the operation is frequently refused, and the ophthalmologist, with the conviction that he has done his duty and has put his conscience at rest by the advice which he has given, is now ready to do the next best thing and orders miotics. Expecting nothing from these drugs, he employs them but indifferently and without method, and as a consequence observes the gradual deterioration of sight. Another surgeon, though equally pessimistic, but more conscientious, employs eserin and pilocarpin more persistently and methodically, and is surprised at the long maintenance of vision. He then begins to question his diagnosis and consider if, after all, the case is not one of optic atrophy with excavation, and not a true glaucoma, though the increasing hardness of the eye serves to convince him more and more that there has been no error and that the case is surely one of glaucoma. I believe that there is scarcely one who has not had this experience and who has not had the conviction forced on him that after all perhaps it was just as well that such patients refused operation.

But it will be said, Who can tell that any given case will progress so favorably? Such experiences are exceptional. and the majority so treated will, after a few months, develop subacute symptoms at least, and loss of sight will be precipitated. It has been my experience that if the disease is of a pure chronic type in the beginning, in the great majority of cases it will remain so to the end, provided miotics are continuously employed. On the other hand, I have observed that if there are any congestive symptoms in the initial stages or shortly thereafter, miotics are powerless to check the disease and early operation is indicated. From a therapeutic standpoint, at least, I would insist, therefore, on the necessity of a separation of all cases of glaucoma into two types, the one congestive, which, despite the use of miotics, presents symptoms of irritation and inflammation in even the earliest stages, and in which early iridectomy is indicated, and the other the non-congestive or chronic, which may continue for many years practically stationary under the employment of miotics.

I have had under my private care at least four cases for twelve years, and for ten years twice that number, and others for lesser periods, on whom iridectomy was not performed, who still retain full vision, though somewhat restricted fields, and it is probable from the progress of the disease that the deterioration in vision will not be much more pronounced at the end of another ten years. As an example of this type I cite the following history:

*History.*—Woman, aged 62, consulted me first in June, 1897, for gradually failing vision. The eyes had never been inflamed or painful, and the glasses which she had worn both for near and far, had always given satisfaction until recently. The patient was strong and healthy, though gouty, but for several years previous to consultation had been under a severe mental strain. She had always been a sufferer from nasal catarrh and had not the sense of smell for several years.

*Examination.*—Examination showed the eyes to be quiet, the cornea being clear and the conjunctiva healthy. The anterior chamber of both eyes was shallow, the pupils were 2.5 mm. in size, reacting well to light and accommodation stimuli. Both optic nerves were hyperemic, of a dirty dull red gray tint, and their excavations extended temporally to a broad scleral ring. Arterial pulsation was absent, but the veins pulsated on the disc. The sclera in both eyes felt rigid, but tension was not apparently increased.

With + S. 1.75 D. with + C. 0.50 D. ax. 30° O. D. V. equaled 5/5.
With + S. 1.25 D. with + C. 0.75 D. av. 60° O. S. V. equaled 5/5.

The field of vision in both eyes was normal both for form and color, and there were no scotomata.

*Treatment.*—Eserin gr. .1 was at once prescribed and the strength gradually increased, as the iris and ciliary muscles grew tolerant of its action. The proper correcting lenses were also selected, and careful instructions given regarding the restricted use of the eyes at near work. Alteratives and tonics were prescribed and the regimen of the patient's life carefully outlined. This plan of treatment has been carefully and conscientiously followed for eight years, the patient submitting herself every two or three months for observation and any necessary change of treatment.

*Results.*—Central vision still remains normal, though the visual fields have suffered a slight restriction nasally for both form and color. There are no scotomata, either by the ordinary perimeter tests or by the method of Bjerrum. Tension, too, has become perceptibly increased in both eyes and the excavations on the head of the nerves are more distinctly glaucomatous and the nerves are paler. The refraction has changed, the last test, 428.06, indicating that it required + S. 2 D. $\overset{\frown}{\smile}$ + C. 0.75 D. ax. 120° to bring the vision to normal in the right eye and + S. 2 D. $\overset{\frown}{\smile}$ + C. 0.12 D. ax 80° to bring the vision to normal in the left eye. The cornea has continued clear.

The eserin has been well tolerated, and having always been prepared with care and in fresh solution, and boracic-acid washes used persistently in conjunction with it, all irritation of the conjunctiva has been avoided. The salicylate of eserin is now being employed in a solution of gr. ii to the ounce.

It is true that the disease has progressed in this case despite the constant use of miotics and diligent care directed to every source which could influence the ocular condition, but the progress has been so slow that in all fairness it may be claimed that the disease has been at least controlled. All here can doubtless quote similar experiences, and in such instances has there been a regret in the minds of any that iridectomy was not resorted to? Before closing this paragraph, however, it should be made clear that if the disease at any time assumes an acute or subacute type iridectomy should at once be performed, and furthermore that if it is impossible to keep the patient constantly under observation, or if miotics can not be persistently and continuously employed operation should be resorted to also.

## II. ADVANCED CASES.

Under this class is considered the not uncommon type where vision in one or both eyes has been seriously compromised by the marked restriction of the visual field. either peripherally by cutting, or centrally by scotoma. All advocates of iridectomy caution about the danger of operating under such circumstances, as it has been a common experience that total blindness has not rarely followed surgical interference. Cases of this type have usually been regarded as hopeless, and blindness, within a few months at best, has been considered to be inevitable. That miotics may be of great service, even in this type, and may accomplish truly wonderful results, is attested by the following case, which I have had under continuous observation since April, 1893:

*History.*—Patient, a man aged 48, was practically blind in the right eye, while the vision in the left was reduced to but a segment of the visual field. The cause of the failure in vision was ascertained to be chronic simple glaucoma, which had followed an attack of grip three years previously.

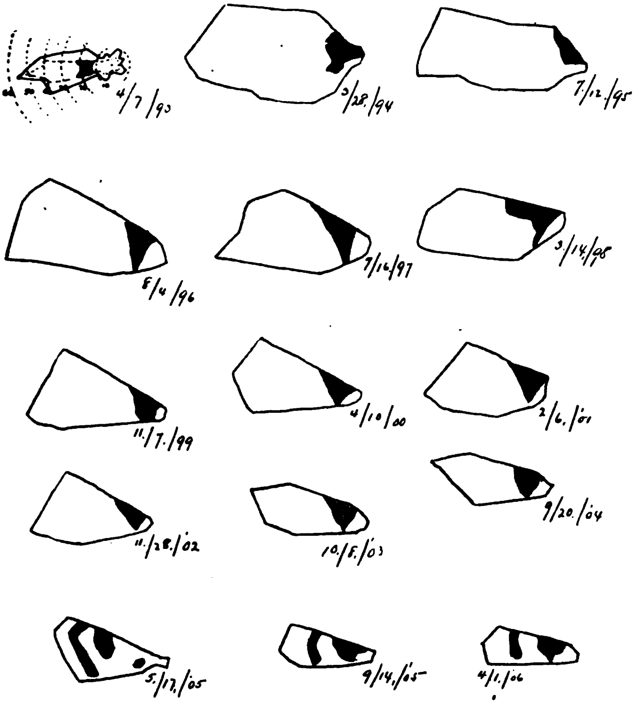
*Examination.*—Both eyes were hard, there being no difficulty in estimating the degree of the hardness in both eyes as at least + 2. The anterior chambers were very shallow, the scleral vessels were dilated and engorged and the nerves were deeply excavated. The general condition was somewhat impoverished, digestion was poor and the nervous force of the individual negative. Nasal catarrh was complained of, and there were repated attacks of rhinitis with sinus involvement; the conjunctiva, however, was clear. Vision in the right eye equaled the perception of hand movements in the temporal field; in the left eye central vision was normal, but as shown in the accompanying diagram, the field of vision was much restricted.

*Treatment.*—Iridectomy being apparently out of the question, on account of the marked limitation of the field, treatment with miotics was inaugurated, though it was felt that but two or three months would suffice to obliterate the small portion of the visual field which remained.

It should be stated in this connection that until this time, although the patient had been under continuous medical care, eserin had never been prescribed, but after the operation was refused, his treatment had consisted in tonics, boric-acid washes and a change of glasses. Under this plan of treatment, the loss in sight had been very rapid and the patient had estimated that should the left eye deteriorate as rapidly as it had during the few weeks before he came to me for advice, blindness would ensue in a month or six weeks.

The salicylate of eserin was accordingly prescribed, in a gr. ss to the ounce dose, conjunctival irritation being guarded against by the treatment which will be described later. Tonics were continued. Attention was directed to the nasal condition. Tobacco and alcohol were stopped, the use of the eyes at near work prohibited, and every effort was made to ameliorate the condition of the general health, and to gain a maximum effect from the miotics. In a few weeks, the eserin was increased to gr. i to the ounce, and a similar increase was made each month until in four months a gr. iv to the ounce solution of the drug was being employed.

*Results.*—The arrest of the glaucomatous process under this plan of treatment was most remarkable, for, as may be seen in Figure 1, the field became less restricted for a time and central vision remained normal. At the end of six months nitrate of pilocarpin in twice the strength was substituted for the eserin, and during the past thirteen years there has never been a day that either eserin or pilocarpin has not been instilled three or four times daily. Slight conjunctival irritation has arisen at times during this interval, but has always readily yielded to treatment. Until three months ago there was full central visual acuity, though as a study of Figure



The fields of vision in the left eye of a case of chronic glaucoma, showing gradual peripheral restriction and the extension of scotoma.

1 will show, as the years went by the field of vision became more and more contracted and the paracentral scotoma has grown steadily larger. Three months ago, after a rather prolonged attack of dysentery, there were several recurring attacks of blindness in the left eye, which persisted for five to ten minutes. These were apparently caused by a temporary interruption in the retinal blood supply, and though they were controlled by strychnia injections into the temple, and nitroglycerin internally, central vision has not arisen to more than 5/7 ½, and the field of vision has remained still more contracted. To-day, thirteen years after the patient came under my observation, vision is 5/7 ½, and the field is as indicated by the lowest chart in Figure 1.

That this truly remarkable result has been achieved by the use of the miotics I believe there can be no doubt. The very great increase in intraocular tension, the shallow chamber and the deep excavation render the diagnosis of glaucoma incontrovertible, while the rapid prevention of the loss in vision in both eyes which was occurring prior to the administration of the eserin indicates the power of this remedy in chronic glaucoma.

### III. PRONOUNCED GLAUCOMA IN ONE EYE, THE OTHER BEING UNAFFECTED, OR WITH ONLY A GLAUCOMATOUS TENDENCY.

Glaucoma is essentially a binocular disease, though a very long period may elapse before both eyes are affected. It not infrequently happens, therefore, that the ophthalmologist is called on to treat one eye in an advanced stage of glaucoma, while its fellow is either normal or presents changes which indicate in a general way merely a glaucomatous tendency. Experience has shown that when iridectomy is performed on the most affected eye, in glaucomas of a congestive type, that a glaucomatous outbreak is frequently precipitated in the other eye. On this account authorities advise the performance of iridectomy on the fellow eye as soon as the wound in the operated eye has healed, and believe that this procedure should be preferred even in cases of chronic glaucoma. where there are indications that if it is not already the seat of glaucoma it is liable to become so.

While my experience leads me to agree heartily with this advice in the treatment of all forms of congestive glaucoma, I do not believe that the same ruling should be made applicable to cases of chronic glaucoma, for I have never seen an acute attack precipitated in the fellow eye by an iridectomy on an eye which was the seat of a non-congestive type of glaucoma. In the cases of chronic simple glaucoma which are occasionally met with where a glaucoma of a congestive type, despite the continuous use of eserin, has developed from a chronic simple glaucoma, pure and simple, iridectomy is, of course, indicated and should be performed, but even under such conditions I have never seen an outbreak follow in the fellow eye when it had been properly guarded by miotics. It goes without saying, almost, that in event of operation in this class of cases the maximum effect of a miotic should be obtained some time before the operation. and that the administration of the drug should be continued in the fellow eye, even if it manifest no symptoms of glaucoma, as long as the patient lives.

The following history illustrates the progress of cases of this type:

*History.*—Miss H., aged 64, consulted me Nov. 22, 1904. Vision in the left eye had been poor for five years, but the deterioration had been much more marked the six months previous to consultation. There was a history of recurrent head pain of several years' standing, but unassociated with attacks of dimness of vision. The general health had always been good.

*Examination.*—Examination showed the right eye to be normal, but the left eye was found to be the seat of a subacute glaucoma, the nerve being atrophic with a deep glaucomatous excavation. Tension equalled + 1. The field in the right eye was normal, but was greatly diminished in extent in the left. With + S. 0.50 D. $\overset{\frown}{\smile}$ + C. 0.50 D. ax. 170°, vision in the right eye was brought to normal; in the left, with + S. 0.50 D. $\overset{\frown}{\smile}$ — C. 2 D. ax. 30°, it equalled but 5/35.

*Treatment.*—A solution of eserin gr. .125 to the ounce was prescribed, this strength being rapidly increased until the pupil was brought to almost pin-point contraction. Despite this treatment, however, the field still further deteriorated and vision sank to 3/60. An iridectomy was accordingly performed on the left eye, the right being kept under the full influence of eserin, both before and after operation.

*Results.*—The progress of the case since the iridectomy was performed has been favorable, vision in the operated eye remaining about the same (2/60), while that in the right eye is still normal. At this time, two and one-half years after the operation, the right eye still remains free from any pronounced signs of glaucoma, no pathologic excavation having appeared and tension being apparently normal. The anterior chamber, however, is somewhat shallow. Eserin has been persisted in continuously and the strength of the drug gradually increased, so that two drops of a gr. i. to the ounce solution are being employed in the right eye at 8 a. m. and 10 p. m., and two drops of a gr. ss to the ounce solution at noon and 6 p. m.

The explanation of the favorable action of miotics in chronic glaucoma resides not only in their power to enlarge the angle of the anterior chamber by the thinning of the iris consequent on the contraction of the pupil, but also, as Wahlfors has suggested, in their action on the choroidal circulation, for when the ciliary muscle is stimulated the choroid is likewise influenced through the contraction of its tensor, and the muscular network of the membrane set in action, the pressure on the sclera relaxed, the mouths of the venæ vorticosæ opened, the amount of lymph within the eye lessened and tension made to fall.

Now chronic glaucoma is essentially, in the early stages at least, a disease of the posterior segment of the eye; its first symptoms are observable in the choroid and about the head of the nerve, and a long period may elapse before the anterior segment becomes appreciably affected. By reason of the double action just referred to, miotics are, therefore, peculiarly valuable in chronic glaucoma, while iridectomy, affecting, as it does, the lymph channels of the anterior segment of the eye alone, is comparatively useless. In acute glaucoma, on the other hand, the reverse is true, for in this type of cases the congestion of the anterior segment of the eyeball is present from the first, and iridectomy, by relieving this and by opening a permanent passage for the escape of lymph, is much to be preferred to miotics, which accomplish this but imperfectly and transiently.

In order to gain the full benefit from miotics in the treatment of glaucoma, it is necessary that they should be properly administered. It should be kept constantly in mind that glaucoma is a steadily progressing process, and that as the eyes, after a time, become habituated to the use of miotics their strength should be gradually increased. It must be remembered, also, that the effects of eserin and pilocarpin persist for two or three hours only, so that the dose should be repeated at the end of this period if their action over the pupil is to be constantly maintained. Finally, the dosage and the irritation occasioned by miotics should be taken into account.

Undoubtedly the objections to the use of miotics when they were first introduced, and which still remain in some quarters, were dependent on the employment of too strong solutions. When used in this way, cramp of the ciliary muscle, with resultant headache and other reflex symptoms, is often so violent that patients can not be induced to continue these remedies, while the occasional occurrence of hemorrhages into the anterior chamber and retina, which have been noted by some observers, has deterred many ophthalmologists from employing them. It has only been within comparatively recent years that the profession has understood the art of commencing with small doses and gradually increasing them until the desired effect is attained, and then maintaining the action by still further, but less frequent, increase in the strength of the solution employed. As was originally suggested by Sir William Bowman, the initial dose of eserin should be weak. An excellent initial dose is gr. .1 to the ounce, the strength being gradually increased, so that at the end of a year the patient should be using gr. i to the ounce, at the end of the second year gr. ii and at the end of the third year gr. iii to the ounce solution. I have never found a stronger dose than this necessary, this strength sufficing to maintain the pupils at the desired point of almost pin-point contraction. Pilocarpin should be employed in twice the strength of eserin and is increased in solutions of equal proportions.

Wicherkiewicz has recently lauded a solution of eserin, pilocarpin and cocain, in which he claims that the pilocarpin and eserin balance the mydriatic action of the cocain, while the miotics maintain their power over the tension. The formula he employs is as follows:

| | | | |
|---|---|---|---|
| Physostigminæ sulphatis | gr. 1/7 | | 01 |
| Pilocarpinæ hydrochloridis | gr. iii | | 2 |
| Cocainæ hydrochloridis | gr. iss | | 1 |
| Aquæ dest. q. s. ad | ℥iiss | 10 | |

The solution is employed at night only in chronic cases, but repeatedly in acute glaucoma. I have employed this combination several times daily in a number of cases, and have found it to act advantageously.

Gentle massage of the eyeball is of decided advantage and should be practiced several times each day, for five minutes at a time. In addition to these local measures, the patient should be instructed as to the number of hours daily the eyes should be used in near vision. All near work should, of course, be much restricted, and should be carried on only under the most favórable conditions regarding illumination, posture of the patient, etc.

Proper lenses should be adjusted to the eyes, both for near and far use, and the refraction should be frequently estimated and any error corrected, changes in the refraction being rendered frequent by the action of the miotics on the ciliary muscle.

As pointed out by Theobald, the astigmatism will often be found to be against the rule in chronic glaucoma, though I believe that this is rather the result of the stretching of the posterior part of the eye than, as Theobald states, the cause of the glaucoma.

A large number of hours daily should be spent in the open air, and, as the disease is undoubtedly frequently the ocular expression of chronic rheumatism and gout, the patient should be urged to spend the greater part of the year under the most favorable climatic conditions to combat that diathesis. The skin should be kept active, the gastrointestinal apparatus regulated, and any local source of inflammation or irritation, neighboring on the eyes, such as inflammation in the nasal passages or their accessory sinuses, should be allayed. Particular care should be given to the peripheral circulation, nitroglycerin and strophanthus being often of value. Zimmerman thinks that adonis vernalis is especially useful in chronic cases. Strychnia should be administered, not only on account of its action on the circulation, but also because of its influence on the optic nerve. On account of their antirheumatic properties, the salicylates are of decided value and should be frequently administered for continued periods.

Although miotics do tend to provoke a certain amount of conjunctival irritation, the excessive reaction which sometimes follows their employment is often mycotic, just as atropin irritation is mycotic, and can be prevented by care in preparing the solutions, while the continuous use of cleansing and sterile lotions in conjunction with the miotics will usually allay whatever slight irritation they occasion.

The miotics which are best adapted to control intraocular tension are the salicylate of eserin and the nitrate of pilocarpin. As pointed out by Landolt, this salt of eserin is more persistent in its effects and less changeable in solution than other salts of the drug, and is less irritating to the conjunctiva. Eserin, however, in addition to its action on the pupil, stimulates the ciliary muscle, and in cases where there is ciliary congestion, as in acute and subacute glaucoma, its use should be conjoined with cocain, which neutralizes its contracting action on the blood vessels and diminishes the sensibility of the ciliary nerves. Pilocarpin may be substituted in such cases, as it has a much weaker action on the ciliary muscle than eserin, though its action on the pupil is also slighter, so that it must be used in twice the strength of eserin to gain the same amount of contraction.

It should be remembered that a moderate amount of pupillary contraction avails but little, and it should be the aim of the surgeon to keep the pupil continually contracted almost *ad maximum.* I prescribe a solution of pilocarpin for use during the day, and one of eserin of twice the strength at bedtime, thereby avoiding the blurring of vision which is occasioned by the action of the eserin on the ciliary muscle during the day, while the eye receives the greatest effect of the drug during the eight hours or more which elapse between the instillations of the drops during the night.

At times, though very exceptionally, a mydriatic effect will follow the instillation of pilocarpin. This has been determined by Lilienfeld[2] to be due to an impurity in the form of jaborin, an isomer of pilocarpin. I have noted this occurrence in one case, but the eyes suffered no injury, intraocular tension not being appreciably elevated.

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[2] Centralbl. f. prakt. Augenhk., May and June. 1901.

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1906.

# THE DIFFERENTIAL DIAGNOSIS AND PROGNOSIS OF TUMORS OF THE UVEAL TRACT.*

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The literature of tumors of the eye covers many hundreds of cases and thousands on thousands of printed pages. The delegation of this subject to me by the officers of the Section on Ophthalmology of the American Medical Association appalled me by its vastness, and I, therefore, selected only one portion, which is, perhaps, its most important phase, that of the differential diagnosis and prognosis of tumors of the uveal tract, dealing with this subject mostly from the clinical standpoint. A companion essay on "The Microscopic Findings of the So-called Leucosarcoma" is offered to the Section by Dr. E. V. L. Brown, of Chicago. The most important monograph on this subject is by Felix LaGrange,[1] which comprises two massive volumes, 1,739 pages in all, and to this work I am indebted for much of the information which follows:

From the richness of its circulation, its complex structure, its superficial situation and its embryology, the eye is greatly exposed to new growths. It is composed of both ectodermic and mesodermic elements, the proliferation or implantation of which gives rise to diverse forms of tumors. I follow LaGrange and classify the tumors developing in the iris, the ciliary body and the choroid under the following heads:

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

[1] LaGrange: "Traite des Tumeurs de L'Oeil, de L'Orbite et des Annexes," Paris, 1901.

1. Cysts.
2. Angioma.
3. Myoma.
4. Sarcoma.
5. Metastatic Tumors (Sarcoma and Carcinoma).

## I. CYSTS.

From their situation we may designate all tumors of the uveal tract malignant as regards the integrity of vision and of the eye itself. Therefore, even the so-called benign tumors, such as cysts, which in other localities would give rise but to deformity or more or less disturbance of function, are dangerous growths to the eye. These forms of tumors are practically limited to the iris. Alt[2] says: "No doubt epithelial new formations occur primarily in the eyeball, springing from the two epithelial layers of the ciliary body or iris, and seem to be benign."

*Differential Diagnosis.*—The diagnosis is generally easy. In the beginning they may be confused with sarcoma, syphilis and tuberculosis of the iris.

Sarcoma develops rapidly; it is plainly seen and presents a dark aspect, very different from the color of the cysts which are, as a rule, gray, yellow, blue, or rarely green. Leucosarcoma of the iris, which is extremely rare, is white, presents a surface rich in blood vessels and somewhat mammillated. Cysts of the iris usually arise after traumatism, whereas sarcoma does not.

Gummata of the iris are generally to be seen in both eyes, preferably selecting the internal or superior segment of the iris. They are yellowish and under specific treatment are absorbed, leaving an atrophic area. They generally arise in the so-called tertiary form of syphilis.

Tubercles of the iris are of a clear yellowish color, occasionally white. They are vascular, round, multiple, grow quickly and progress rapidly to suppuration in the anterior chamber and perforation of the cornea. While tubercle bacilli are not always found, yet the growths are generally consecutive to general tuberculosis. The rapid course of the affection, the aspect of the growths, the absence of traumatism, should clear the diagnosis. The differential diagnosis of tuberculous tumors of the iris, ciliary body and choroid is helped by hypodermic injection of tuberculin. There is a general reaction in at least 85 per cent. and some local reaction in about 50 per cent. of the cases.[3]

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[2] Am. Jour. Ophth., April, 1902.

Lepra-tubercles occur in the iris as well as the conjunctiva, but other evidences of leprosy as well as severe iritis are always present.

Angiomata of the iris and pigmented nevi should not be confused on account of their aspect.

Dermoid tumors look like pearly growths. They are, however, of congenital origin.

Cysticercus of the iris should be recognized by the caudal vesicle and the head.

The presence of cystic tumor of the iris being determined, we should recognize whether it be a simple cyst, a pearly tumor or a dermoid. Simple cysts are transparent and translucent. Pearly tumors are milk white and look like a little pearl. They are usually round, sometimes bosselated, and frequently ultimate in simple cysts. These cysts of the iris frequently pass from the anterior chamber and apparently combine with other structures of the eye.

*Prognosis.*—The prognosis of cysts of the iris is usually grave, as they predispose this structure to iritis and iridochoroiditis. One case of sympathetic ophthalmia has been reported by Rothmund and Critchett.[1] Cysts of the ciliary body and choroid may follow traumatisms, operative or otherwise.

### II. ANGIOMATA.

Only 19 cases of angiomata of the uveal tract have been reported, and the diagnosis of these is disputed by Schieck, who claims that all these cases (certainly 12 of them) are examples of melanosarcoma. These have all been in the choroid and have led to destruction of the eye and, in some cases, life. One of these was my own, described later, which was an angiosarcoma of a metastatic type. The ophthalmoscopic examination in the early stage usually shows a brown tumor, the character of which is discovered after enucleation.

### III. MYOMA.

Myoma of the uveal tract has been rarely described in literature, the first case being by d'Iwanoff-Wecker in 1867. The others are by Salomon, Mules, Deutschmann, Lange, and Guaita.[1] We would expect muscular tumors to be developed in the iris, ciliary body and the choroid on account of the muscle fibers in these structures. Guaita is the only one who has thoroughly described a case and given microscopic illustrations. If we accept his observations, it is certainly conclusive that muscular tumors may arise in these structures.

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[3] C. H. Bull: Medical Record, Dec. 9, 1905.

### IV. SARCOMA.

We now come to the most important portion of this subject, sarcoma of the uveal tract, of which there are many varieties and which have been described by writers under a number of subdivisions. For diagnostic and prognostic purposes we can not accept the statement of Schieck that these are all melanosarcomas. For convenience of description, we put them under two general groups: (1) Melanosarcoma, in which the chromato-

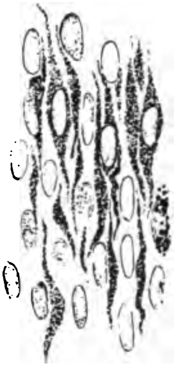

Fig. 1.—Fusiform cells with chromatophores in various stages from the cortex of a melanosarcoma (Schieck).

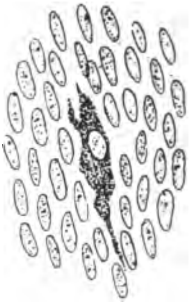

Fig. 2.—Chromatophore in a leucosarcoma (Schieck).

phores are so thick that the tumor appears blackish or brownish to macroscopic examination and in which pigment cells are plentiful under the microscope; (2) leucosarcoma, in which the tumor is white and chromatophores are with difficulty found under the microscope may be made as follows:

a. According to the form of the cells:

- Round (encephaloid).
- Fusiform (fibro).
- Giant (myeloplax).

b. From the origin of the epithelium and the grouping of the cells:

- Hemangiosarcoma.
- Lymphangiosarcoma.
- Alveolar.
- Tubercular.

c. According to the vessels:

- Telangiectatic.
- Cavernous.

The diverse degenerative forms, myxosarcoma, cholesterinsarcoma and the combined forms of osteosarcoma, chondrosarcoma and tubercular sarcoma, would give still further varieties. The differentiation of its forms is of importance, the pigmented tumor being much more malignant than that without or with few chromatophores.

LaGrange[4] says: "As regards the origin of the pigment, microchemical reactions do not permit us to distinguish hematogenous pigment from that arising in the cells themselves. The hematogenous pigment is found particularly near the vessels, the autochthonous scattered through the tumor. The pigment arises chiefly from the normal cells of the choroid, although the blood also plays a considerable rôle. Tumors with hematogenous pigment appear to be less malignant than the others."

Tashiro[5] sums up the result of his work as follows:

"1. The polymorphous cells composing melanosarcoma are of the same origin. The differences in shape depend partly on the irregularities in the shape of the chromatophores from which the cells spring, partly on the rapid production of cells which have not reached their full development, and partly from the hypertrophy and breaking down of the cells. 2. The unpigmented cells in a melanosarcoma are quite similar ele-

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[4] Arch. d'Ophth., vol. xxi, No. 4, p. 177.

[5] Inaug. Dissert., Halle, 1902.

**ments. In the case of these cells the proliferation is too rapid to allow the formation of pigment. 3. The pigment cells produce their pigment in a metabolic manner by the protoplasm being gradually transformed into melanin. The hemoglobin is here only an oxygen carrier. 4. The retinal epithelium takes no part in the structure of melanosarcoma, but it may proliferate harmlessly in cases of sarcoma of the choroid. 5. Melanosarcoma is composed of a specific variety of cells which arise from chromatophores, a sort of connective tissue, and are characterized by their irregular shape and the production of melanin. Just as carcinoma arising from goblet cells becomes carcinoma mucosum, a special variety, so melanosarcoma is a special variety. Ribbert suggests the name chromatophoroma for the true cases in order to distinguish them from sarcomas that are accidentally pigmented."**

Franz Schieck's recent book[6] seeks to prove by a complete anatomo-pathologic report of 24 of the author's own cases of uveal tumors and a review of all fully reported cases in the literature of leucosarcomas and angiosarcomas that all sarcomas of the uveal tract are more or less pigmented and should be classed as melanosarcomas. From the microscopic standpoint we agree with Schieck, for, even in the white sarcomas, chromatophores are to be found (Figs. 1 and 2). We must, however, side with LaGrange (whose descriptions and differentiations the former author attacks) that there is a difference in the prognosis, as regards sight and life, to be made from the macroscopic as well as the microscopic characters of these growths. Those containing embryonal tissue mostly are probably more malignant and subject to recurrence, and especially those that are so deeply pigmented as to be deemed melanotic on macroscopic examination.

Schieck states that from the critical examination of the many cases of melanosarcoma which have been "wrongly described" under other names he finds no evidence that other than pigmented sarcomatous growths arise in the uvea, and he considers that all such should be described as melanosarcoma.

*Aids to Differential Diagnosis.*—The differential diagnosis of intraocular tumors is materially helped by the following methods and instruments of precision: 1. The magnifying glass or loupe, particularly the binocular form. 2. The condensing lens for oblique illumination. 3. The ophthalmoscope. 4. Transilluminating apparatus. 5. Exploratory puncture.

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[6] "Das Melanosarkom als Einzige Sarkomform des Uvealtraktus," Wiesbaden, 1906.

Tumors of the iris and ciliary body can be seen by the external methods; those of the interior of the eye, in their first and second stages, occasionally by oblique illumination,[6] usually by the ophthalmoscope, and the diagnosis confirmed by transillumination.[7] I will not dwell on the three former methods, but the latter, a modern innovation, is certainly not in general use, although it is most valuable. This consists of sending a beam of light through the eye, in a dark room, by such instruments as have been devised by Rochon-Duvigneaud, Sachs and Leber and the modification of the former made by the author.

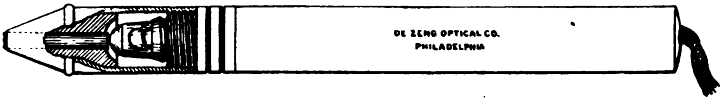

Fig. 3.—Ocular transilluminator (author's model.)

My model consists of a tube containing a small electric light, in the end of which is a covered glass rod, free at one end, permitting light to pass through. The end of the rod is placed against the lids or sclerotic, in the latter case the eye being anesthetized by cocain, when, if there be any obstruction of size in the eyeball, a shadow will show similar to that in transillumination of the face for the determination of disease within the maxillary antrum and other accessory cavities of the nose.

Exploratory puncture has been tried by Schulz[8] and Hirschberg,[9] but is dangerous and liable to cause metastasis. The diagnosis of tumor of the eye is self-evident after perforation of the globe or involvement of contiguous structures.

*Sarcoma of the Iris.*—The diagnosis of sarcoma of the iris does not usually present any difficulty. It may be confused with pigmented nevi or melanoma, which are not usually progressive, but which are held by some authors to be the starting points of melanosarcoma.

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[7] When the tumor is posterior to the equator, of course transillumination is not of pronounced value.

[8] Klin. Monatsbl. f. Augenheilk., vol. xxxviii, p. 315.

[9] Berl. klin. Wochft., Nos. 4 and 5, 1904.

[10] Centbl. f. prak. Aug., vol. xxvi, p. 129.

Fehr,[10] fifteen months before the diagnosis was made of a melanosarcoma of the choroid extending into the ciliary body, found deposits of pigment on the iris and Descemet's membrane. After the enucleation, preceded at the wish of the patient by a puncture, there was recurrence in the conjunctiva, notwithstanding the careful removal of the punctured spot. The author concludes that pigment deposits in eyes which have not been injured, inflamed or degenerated should excite suspicion of tumor. Hirschberg[11] says congenital pigment nevi of the cutis, as life advances, tend to be converted into melanotic tumors, and gives three cases of circumscribed pigment spots of the iris which became melanotic sarcomata.

Cysts of the iris are usually round and of a bluish transparent aspect. Gummata of the iris and tuberculous tumors are usually accompanied by iritis, the pupil is not mobile, the inflammation causes synechiæ, which, with the deposits on the membrane of Descemet, the course of the case, the rapid effect of constitutional treatment, should clear the diagnosis.

Occasional cases of iridic gumma, on first examination, present a striking likeness to primary sarcoma of the iris, as I myself have found, most notable in one case at least. This was in an unmarried female, age 21, whose appearance, history and environment seemed to negative the existence of syphilis. A reddish brown tumor of 3 mm. diameter was observed about the middle of the iris in one eye. Dilatation of the pupil showed only one synechia, and this at the site of the tumor. The eye was said to have been sore for about one year and at first had been inflamed. A tentative diagnosis of either sarcoma or gumma was made; the latter was substantiated by the rapid disappearance of the growth under mercurial inunctions, pilocarpin sweats and iodid of potash. A history of exposure was afterward obtained.

Wood and Pusey[12] report 96 cases of primary sarcoma of the iris. Enucleation was done in 57 cases. Eliminating 16 cases, which must be excluded from consideration for various reasons, there remain 41 cases in which the histologic examination of the enucleated globe showed involvement of other parts than the iris. Iridectomy was done in 27 cases; in 3 the results were bad; in 18 the notes form interesting reading; in some of them the continued growth of the tumor was only too evident. In estimating the results it is necessary to remember that the growth of these tumors is usually exceedingly slow, warning one not to be too certain of a cure until a long time—more than three years—has elapsed after the removal. In 5 cases observed for more than three years there were no recurrences. In one case in which there was apparently no return, the eyeball was enucleated eleven years after the iridectomy; it showed inflammation of the ciliary body and remainder of the iris with tumor cells; sixteen years after the iridectomy the patient died from general sarcoma.

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[11] THE JOURNAL A. M. A., Nov. 25, 1905.

[12] Arch. of Ophth., July, 1902.

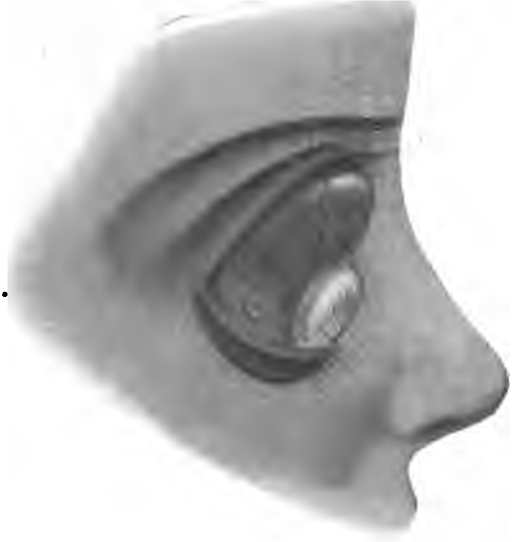

**Fig. 4.—Extensive ectasia of ciliary region presenting external appearance similar to my case shown in Figure 5 (Vossius).**

*Sarcoma of the Ciliary Body.*—The diagnosis is relatively easy, although it might be confused with gumma, tubercle, or even with glaucoma attended by protrusion of the ciliary region, but these are attended by evident inflammation, which is not at first the case with sarcoma. In the case of ciliary sarcoma there is at first no special inflammation nor increase of tension, although as the tumor grows these conditions obtain. Subconjunctival cysticercus about the ciliary region should be recognized by its color, translucence of its vesicle and its movements.

*Sarcoma of the Choroid.*—This is the most important part of our subject and the most common place of origin. The growth may arise in any part of the choroid, in the ora serrata, the equator, the macular region, and about the papilla. It is usually of a mountain shape, but may have a constriction or neck or may be a flat growth. The most common place of origin is in the ora serrata and here the ciliary body speedily becomes implicated. For purposes of diagnosis and clinical history it may be described under four stages:

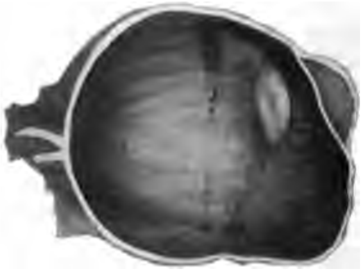

Fig. 5.—Section of eye with extensive ciliary ectasiæ simulating intraocular growth, attended with hypertension, enucleated under suspicion of tumor (author's case).

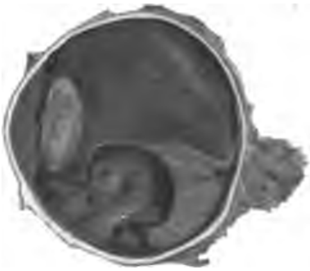

Fig. 6.—Primary melanotic sarcoma of choroid (author's case).[13]

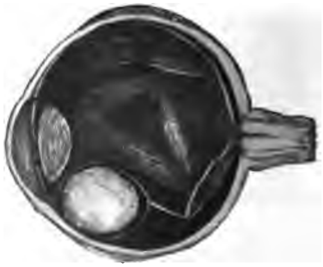

Fig. 7.—Primary leucosarcoma of choroid (author's case).[13]

1. First Period: The patient comes on account of disturbance of vision. We find lowered visual acuity and

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[13] Annals Ophth., vol. xi, p. 439.

scotoma or absence of the visual field corresponding to place of origin of the tumor, which is to be seen in the eye by the ophthalmoscope, sometimes by oblique illumination, and, if the tumor be within the anterior portion of the choroid and ciliary body, a typical shadow will be obtained on transillumination.

At times these tumors may be anomalously placed and thus be at first overlooked, as they may resemble intraocular blood clots.[14] Parsons reports 31 cases of diffuse sarcoma from the literature.[15]

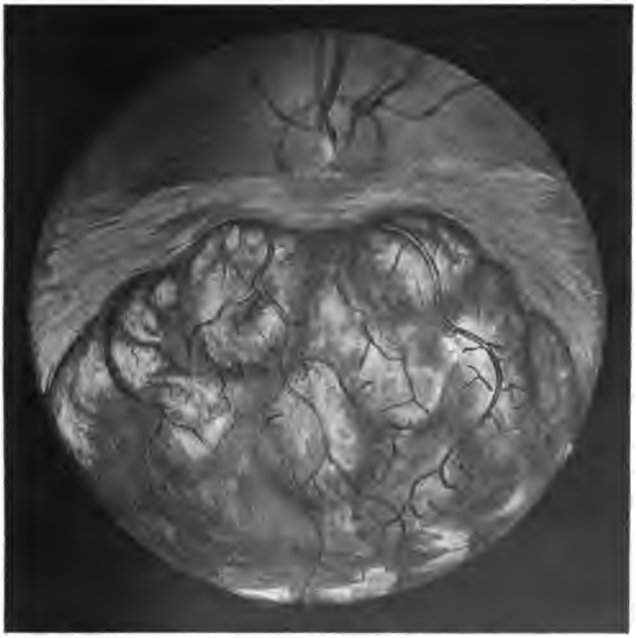

Fig. 8.—Ophthalmoscopic appearance of melanosarcoma of the choroid (author's case).

We first observe detachment of the retina, which is an early sign, but with which it must not be confused. Sarcoma is usually of a round form and the retina is stretched more or less tightly over its surface, the retinal vessels being present, but, in addition to these, there are also the true vessels of the tumor which render the protrusion much more vascular than in the case of simple retinal detachment. The tumor is always darker, even in the case of the feebly pigmented growths, because the pigment layer of the retina covers the tumor (Figs. 6 and 7 and fundus pictures Figs. 8 and 9).

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[14] Parsons: Brit. Med. Jour., vol. xix, 1904.

[15] Arch. of Ophth., vol. xxxiii, p. 2, 1904.

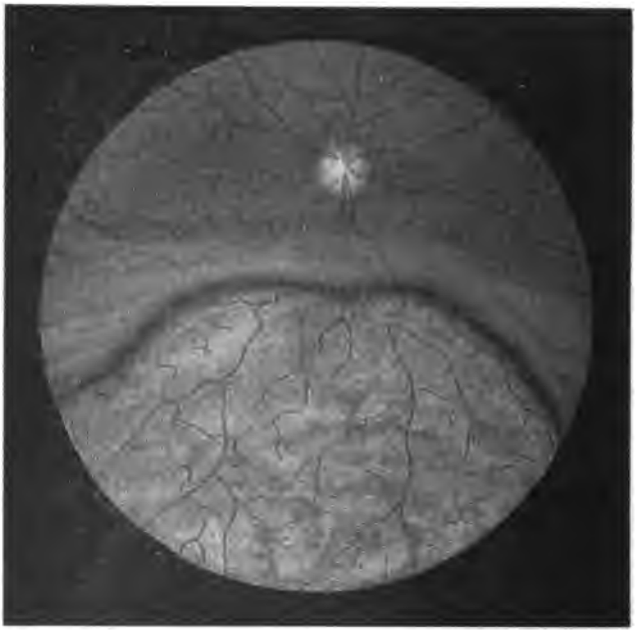

Fig. 9.—Ophthalmoscopic appearance of leucosarcoma of the choroid (author's case).

In simple retinal detachment the folds of the retina are much more numerous and may change in position from time to time or while under observation. There is certainly subretinal fluid in connection with sarcoma, but in the latter case the detached retina does not vibrate, for the fluid is a jelly-like exudate, an albuminous coagulum, while in the former it is usually more of the consistence of blood serum.

The diagnosis is readily established by the method of transillumination in connection with the ophthalmoscope, the history and course of the case. Retinal detachment, except in the case of myopia, and sometimes even here, generally follows some accident. In sarcoma the patient can rarely actually designate a previous traumatism.

Tubercles of the choroid are recognizable under the ophthalmoscope as whitish nodules, occupy a considerable space, and are accompanied by inflammatory reaction, which is absent in the first stage of sarcoma.

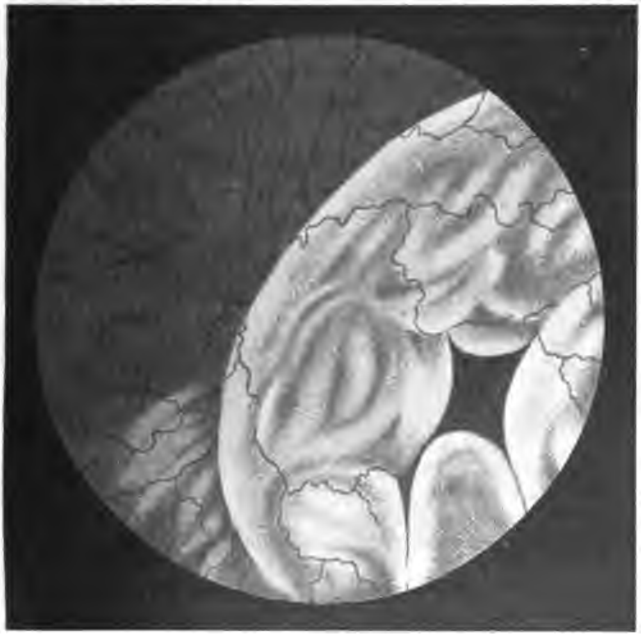

Fig. 10.—Partial detachment of the retina (Haab).

Cysticercus under the retina may at first be confounded with beginning sarcoma, but this affection is extremely rare in America, being more common where raw or poorly cooked meat is customarily eaten, as in Germany. The movements of the animal, the opaqueness of the retina over it, and the inflammatory reaction, are usually sufficient to determine the diagnosis.

Glioma and pseudoglioma of the retina are somewhat more difficult of diagnosis. Glioma usually appears in infancy, its glaring amaurotic cat's eye, presence of its peculiar vessels, and the fact that it is composed of retinal tissue and not merely covered by the retina, are in the early stages to be readily determined by the ophthalmoscope. Its rapid course in comparison to the comparatively slow growth of sarcoma is another useful point for diagnosis. Pseudoglioma, or suppurative choroiditis, it to be determined by the minus tension and inflammatory symptoms, absent in the early stages of sarcoma.

2. Second Period: Sarcoma is apt to be confounded in its second stage with two affections: Absolute glaucoma and suppurative choroiditis.

Absolute glaucoma with cataract presents an appearance very like to sarcoma; many eyes have been removed and many errors in diagnosis made even by the most accomplished and experienced ophthalmologists, among whom may be quoted Graefe, Jacobi, Knapp and Hasket Derby[1] and many others of less experience, including myself. Certainly the symptoms are much the same, viz.: the pain and the tension of the eyeball. These vary in glaucoma, while in intraocular growths the symptoms are progressive, the eyeball becoming so tense and hard that finally amelioration results from bursting of the globe. Both symptoms are the results of concomitant glaucoma occurring from the enlargement of the tumor and encroachment on the contents of the eyeball.

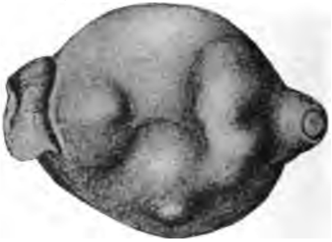

Fig. 11.—Second stage of intraocular sarcoma in which the tumor fills the eyeball (author's case).

Chronic suppurative choroiditis is very rarely accompanied by hypertension. It has, however, followed a primary growth within the eye and resulted in secondary atrophy of the eyeball.[16] Terrien and Coutela[17] refer to the fact that sarcoma may arise in an atrophied eyeball, but believe that the germ of sarcoma must preexist, perhaps in the form of pigmented nevus of the iris.

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[16] Schultz: Arch. f. Augenheilk., vol. xlii, p. 56; also Key: Hygeia, February, 1900, and Terrien: Arch. d'Ophth., vol. xxix.

[17] Arch. d'Ophth., November, 1905.

3. Third Period: Here the diagnosis of choroidal sarcoma should not present any difficulty, for the eyeball has ruptured and the growth is fully apparent.

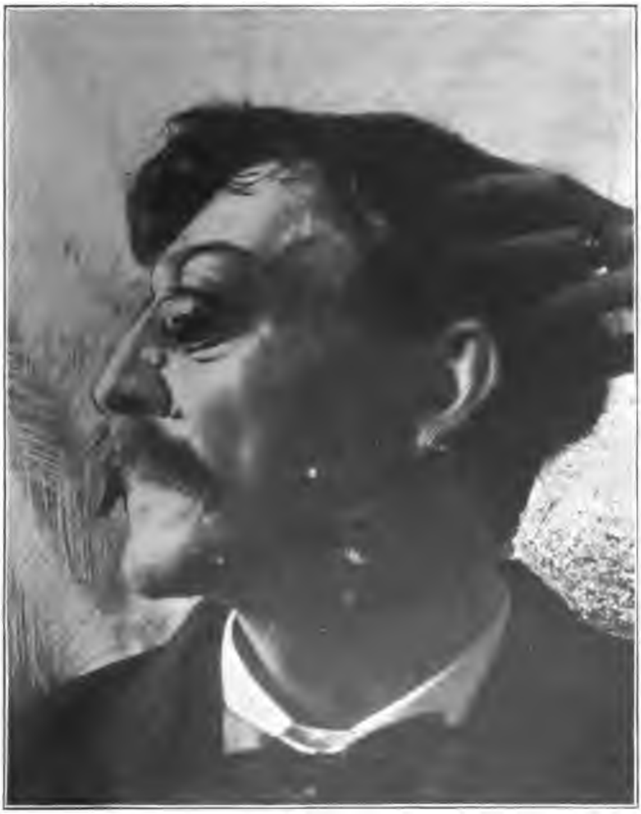

Fig. 12.—Sarcoma of choroid, third stage. Exenteration of orbit; death from cerebral complication eight months later (author's case).

However, an epibulbar tumor may so encroach on the eyeball as to gain entrance and, if seen at this time, may simulate a growth of intraocular origin. The diagnosis should be made from its history and its course.

4. Fourth Period: Where the tumor growths become

generalized we may not always be able to determine the origin, whether from the surrounding structures or from the inner parts of the eye. However, at this time the diagnosis, prognosis and treatment may practically be limited to naming the disease, stating that it is fatal, and preparing for a lethal ending.

*Leucosarcoma of the Iris.*—As before noted, I have deemed it advisable for purposes of diagnosis and prognosis to make a distinction between the feebly pigmented variety, leucosarcoma, and the melanotic form.

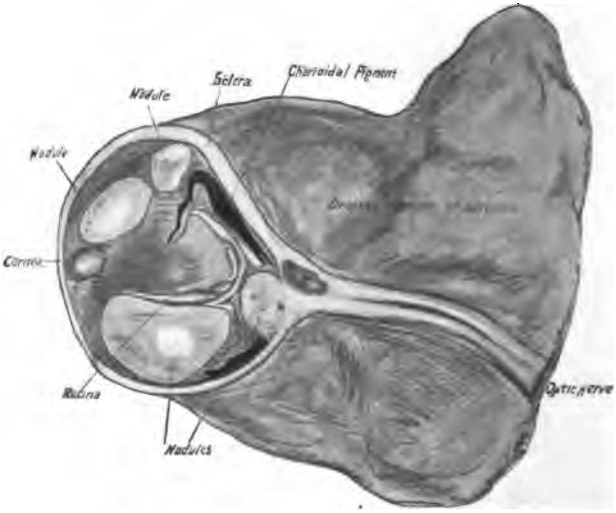

Fig. 13.—Section of tumor including globe. Specimen from patient, Figure 12 (author's case).

The diagnosis of nonmelanotic sarcoma may be confused with cysts or pearly tumors. These, however, are hyaline, transparent, usually of a bluish color, and without vessels. Gummata of the iris are yellow, multiple, implanted about the ciliary circle, and accompanied by other manifestations of the diathesis. Tubercles are multiple, composed of disseminated little tumors, which should not be confounded with the one mass of leucosarcoma. They develop very rapidly and arise in young subjects who present tuberculous antecedents. Lymphomata resemble tubercles. Leprous growths are accompanied by other characteristic symptoms and are usually localized at the sclerocorneal limbus. Cysticercus should be recognized by the animalcule. The melanotic tumors of the iris have been described.

*Leucosarcoma of the Ciliary Body.*—This may be confused with the other malignant tumors, carcinoma and melanotic sarcoma. The diagnosis can not be made in the primary stage, but may in the secondary from the appearance of the growth. There are only five cases described in literature.[18] It is primary and can not be differentiated *in situ* from melanosarcoma. Tubercular pseudo tumors develop in the ciliary body, but are accompanied by general symptoms.

*Leucosarcoma of the Choroid.*—This may be confused with glioma of the retina and simple detachment. In glioma there is the characteristic localization of the growth, which almost generally arises about the optic nerve, the absence of the retinal vessels, its characteristic appearance and rapid growth into the vitreous.

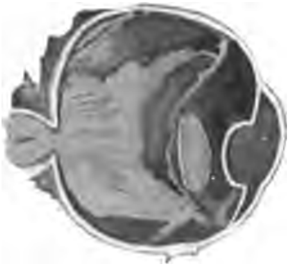

**Fig. 14.**—Glioma of the retina (author's case).

The diagnosis between leucosarcoma and detachment of the retina is not so difficult if transillumination be used.

### PROGNOSIS OF TUMORS OF THE UVEAL TRACT.

The prognosis of tumors of the uveal tract depends on their nature. Intraocular tumors may always be deemed malignant to the function and to the viability of the organ itself; they demand excision; in the majority of cases enucleation of the eye and in a considerable minority exenteration of the orbit and subsequent *x*-ray treatment. There is a certain amount of difference between melanosarcoma and leucosarcoma as regards the prognosis. Certainly the statistics of melanosarcoma of the uveal tract show that it is more dangerous to life than leucosarcoma. I have been unable to differentiate the various cases in the many reports that have been made on this subject, as many are duplicates.

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[18] Moissonnier: Arch. d' Ophth., March, 1905.

Fuchs[19] reported 13 cases of melanotic tumors of the iris, 20 of the ciliary body and 196 of the choroid. Of 10 iris cases, 6 were operated on with success—one by iridectomy and 5 by enucleation. Of 11 cases of the ciliary body, 6 with success; 115 of the 196 tumors of the choroid with success, 75 terminated in death, and 15 recoveries out of 40 of the others during the first six months; of the 75 mortal cases, 37 recurred in the orbit. Badoin[1] reviews 130 additional cases in which there were 29 recoveries.

The microscopic diagnosis is of importance, because embryonal cells without pigment are much less apt to form recurring growths than those having fusiform elements with pigmentary migration and proliferation. In 76 cases examined by Fuchs[19] 46 had embryonal cells and 31 fusiform cells; in 33 cases there were 18 recoveries and 15 deaths. In melanotic tumors Fuchs[19] and LaGrange state that metastasis occurs in 19 per cent., in leucosarcoma 7 per cent. In melanosarcoma there is recurrence in 14 per cent.; in leucosarcoma only 3 per cent. Statistics seem to show that in leucosarcoma about 25 per cent. have been operated on with definite result after three years. In melanosarcoma the percentage is about half of the former. Hirschberg[20] believes that patients who remain healthy after four years may be considered permanently cured, but he has noted an exception in 2 cases of metastasis of the liver nine years after enucleation of the eyeball. Goldzieher[21] reports a similar case.

The most important recent contribution to the question of recurrence *in loco* and metastasis after enucleation for choroidal sarcoma is by Hirschberg. He records the statistics of 68 cases of sarcoma of the uveal tract seen between the year 1872 and 1903; of these, 63 were in the choroid; 66 enucleations were performed. There were no deaths from the primary operation. Local recurrence was observed only once, in which perforation had occurred before enucleation. In 2 out of 6 cases

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19. "Das Sarcom des Uvealtractus," Wien, 1882.

20.—Berl. klin. Wochenschr., Nos. 4 and 5, 1905.

21. Centbl. f. Augenheilk., p. 135, 1904.

in which puncture of the eyeball for diagnosis was made previous to operation, there was a recurrence in the position of the conjunctival puncture, so that he advises against this procedure. Death occurred from metastasis in 16 cases—in 12 of these within two years. Of 41 cases that could be properly followed, one died from local recurrence, 2.5 per cent.; 17 from metastasis, 41.5 per cent., and 23 remained healthy, 56 per cent. This is the best record of success thus far published. Of 47 cases in which anatomic examination was recorded, 35 were melanotic, 9 slightly pigmented, and 2 leucosarcomatous.

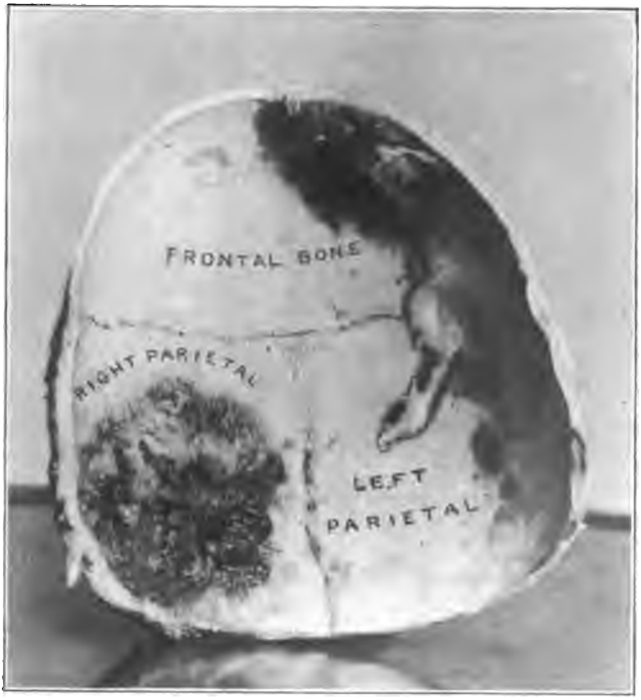

Fig. 15.—Metastatic angiosarcoma, final stage, showing implication of cranial bones (author's case).

### V. METASTATIC TUMORS.

Metastatic tumors of the uveal tract are rare; the majority have been primary, their origin being in the choroid or orbit, secondarily involving the brain and other structures of the head and of the abdomen. There are only five published observations of primary metastatic sarcoma of this region, by Pflueger, Schweiss-Roth[1], Weiner, Michel, and Würdemann.

In Wiener's case[22] there were multiple sarcomata scattered over the body (Hodgkin's disease?). The growth was said to have originated in the mediastinum. Michel[23] reports one case of Hodgkin's disease which was also considered primary in the mediastinum. I believe, how-

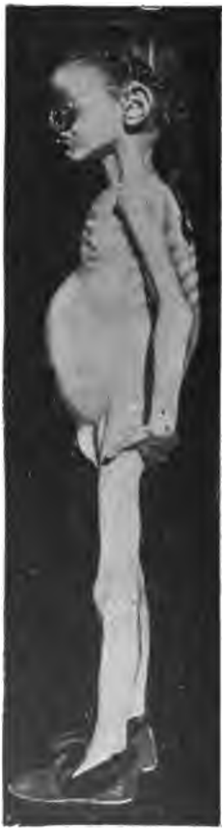

Fig. 16.—Metastatic angiosarcoma, final stage, three days before death (author's case).

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[22] THE JOURNAL A. M. A., Nov. 8, 1902.
[23] Zeitft. f. Augenheilk., vol. xiv, 1905.

ever, that it is the consensus of opinion that these growths must have been primary in the eye or orbit. Certainly that is the history of my own case[24], which was an angiosarcoma with but little pigmentation, apparently originating in the orbit, but the section showing that it involved the eye and choroid, so that a positive determination as to place of origin could not be made. Large secondary growths appeared in the bones of the skull and many in the abdomen, the largest in the latter arising in the tissue back of the kidney, weighing 1,660 gm. All of these cases were fatal.

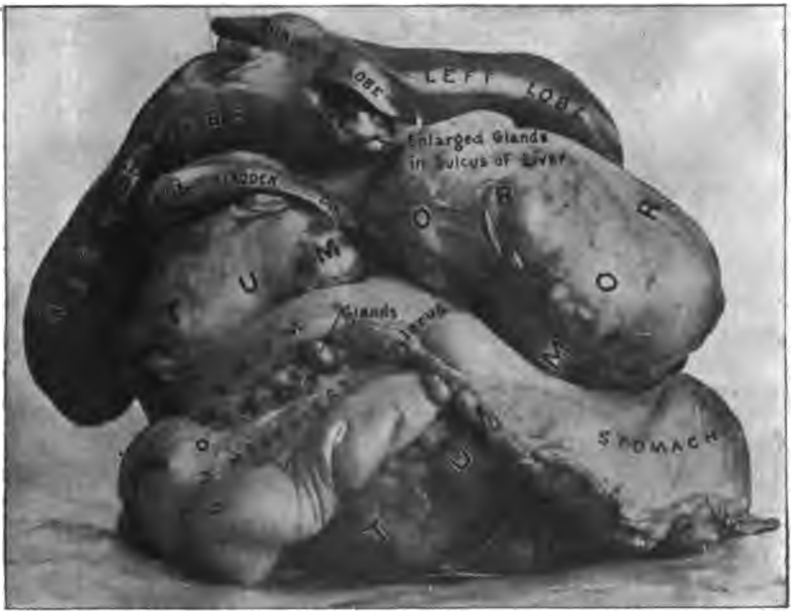

Fig. 17.—Metastatic angiosarcoma, showing inferior view of abdominal viscera and tumors (author's case).

*Metastatic carcinoma of the iris* has not been reported. Uhthoff[25] reports one case of carcinoma of the *ciliary body,* originating in the intestine, commencing as an acute iritis with formation of tumor.

*Metastatic carcinoma of the choroid* is an affection of which only 46 observations have been recorded; one-third of these were bilateral[26]. Oatman[27] says that in every case the growth began in the posterior portion of the choroid, and that two to eight weeks elapsed from the first symptom until the vision is lost. Duration of life averages 6½ months; Marbe says one year. The primary growth may be in the abdominal cavity[28]; the

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[24] —Am. Jour. Med. Scien., June, 1899.
[25] Die Ophth. Klinik., No. 22, 1904.

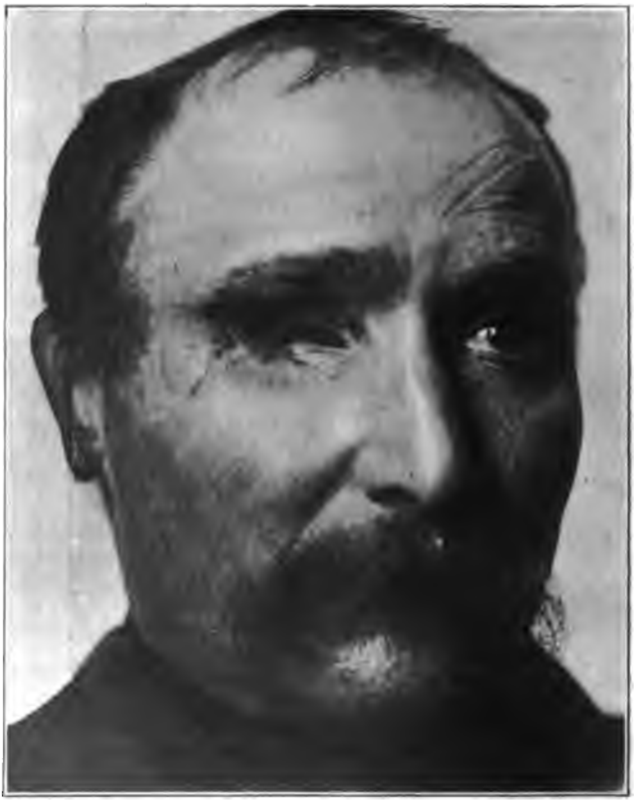

Fig. 18.—Results of operation and Roentgen ray treatment after four years. Carcinoma of eye and contiguous regions (author's case). Patient had several operations and cancer paste in year previous to radical operation of exenteration of orbit, removal of portions of frontal and malar bones. X-ray used several times a week for nearly two years afterward.

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[26] Marbe: Deutsche med. Wochft., No. 27, 1905.

[27] Manhattan Eye and Ear Hosp. Rep., 1904.

[28] Oatman, Marbe, Uhthoff: Klin. Monatsbl f. Augenheilk., November, 1904.

lung[29]; the ovary.[30] Here, however, I would briefly report one case of primary carcinoma of the lids which secondarily involved the eyeball, orbit, and contiguous regions, in which most radical surgical intervention and subsequent *x*-ray treatment resulted in complete recovery (Fig. 18).

The differential diagnosis is to be made between sarcoma, glioma, angiosarcoma, angiocavernous sarcoma, tuberculosis, hyalitis, and exudative metastatic choroiditis.

Sarcoma of the choroid is unilateral; only three cases of bilateral sarcoma have been reported. The determination of malignant tumor in both eyes shows that it is most probably carcinoma. The site of carcinoma is characteristic. Sarcoma develops indifferently, while carcinoma has a predilection for the posterior pole, especially the optic nerve or the macular region. Carcinoma has a diffuse flattened form; the retinal pigment is absorbed. The course of carcinoma is very quick, developing within a year, while sarcoma may take many months or years.

In glioma of the retina the latest age is 9 years. Carcinoma is of late adult life.

In angiosarcoma determination is to be made after enucleation or postmortem.

Tuberculosis of the choroid has been dwelt on.

Hyalitis or suppurative choroiditis has likewise been described and both are accompanied by minus tension and inflammatory symptoms.

## TREATMENT.

Although it is not the province of this article to discuss treatment, yet a brief résumé may be apropos. Where positive diagnosis of benign tumor of the iris may be made and the growth threatens loss of function, iridectomy should be done. Enucleation with a long section of the optic nerve should be made in the early stages of sarcomatous growths, and the case should remain under observation for at least four years, when, if recurrence takes place in the orbit, exenteration should be performed. If the case be seen in the second or even in the third stages, exenteration of the orbit, with subsequent *x*-ray exposures for many months, should be made. I have four cases now living in which the latter procedures were done, three to six years from present writing, in which the patients are alive with no recurrence of the growths.

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[29] Rowan: Trans. Ophth. Soc. Un. King. xix. p. 103.
[30] Holden: Arch. Ophth., xxxiii. p. 322.

In the various forms of sarcoma we may hope to preserve life, but not the eye. There is more hope in the non-pigmented than in the pigmented form. In carcinoma I know of only one case, my own, in which life has been saved. Young subjects certainly present a far less somber prognosis than the aged.

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CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# SO-CALLED LEUCOSARCOMA OF THE IRIS.*

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**CHICAGO.**

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It has long been known that most sarcomas of the uveal tract contain more or less pigment, but it remained for Ribbert,[1] in 1897, to first maintain that all so-called leucosarcomas were in reality made up exclusively of pigment-bearing stroma cells and their derivitives.

He conceives of a species of cell "reversion," by which the normally pigmented chromatophore recurs to its embryonic prototype, and is then later encountered in tumor formation in its successive stages of development, as, namely, the unpigmented, small round cell, the spindle cell (either pigmented or unpigmented), or as the fully developed, branched and pigmented chromatophore differing in no way from its physiologic predecessor. No other type of cell increase, such as that from ordinary connective tissue, vessel endothelium or perithelium, ever produces uveal sarcoma.

Sweeping as these statements seem on first consideration, various other writers, and notably Tashiro[2] and

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

[1] Ribbert, H.: "Ueber das Melanosarkom," mit Taf. XXII, Beitraege z. path. Anat. u. all. Path., 21, 3, pp. 411-499, 1897.

[2] Tashiro, A.: "Ueber Bau und Pigmentirung der Aderhautsarkome." Inaug. Diss. Halle a. S. 59 pages, mit. Taf. III 1902.

Schieck,[3] have contributed a series of articles which substantiate, in the main, Ribbert's theory. They have described in detail a large number of leucosarcomas in which they demonstrate isolated, pigmented and branched chromatophores surrounded by wide fields of unpigmented cells; they most emphatically deny that these pigment cells are only remnants of the normal pigment cells of the uvea, as claimed by Lagrange.[4] But what is far more conclusive, they have shown the analogy and perhaps the identity between these cell forms in uveal sarcoma, and the various stages of development of the choroidal stroma cell as studied in the human embryo by Riecke.

Riecke[5] finds that chromatophores first appear in the choroid in the seventh month of fetal life. He distinguishes two forms of unpigmented cells, the spindle and the star form, bound together by a network of long and short processes. The spindle cell has bipolar processes and an oval nucleus; the star form has several processes, some of which show nodular swellings at the end, and a large, rounded, vesicular nucleus. In addition to these two types, a few isolated, longish nuclei, bordered by a scant rim of protoplasm, are encountered. These cells, too, are looked on as chromatophores, because they, in common with the spindle cell and the star-shaped cells, have the characteristics of all chromatophores, namely, a sharply contoured and plainly granular nucleus. The form of the pigment and its first appearance in the cell is worthy of note. Molecules of unequal size arrange themselves in the protoplasm about one pole of the nucleus, and in a double row along the sides of the processes, the axes remaining free; nearer the center of the cell the pigment is almost unmeasurably fine.

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[3] Schieck, F.: "Ueber die Ursprungsstaette und der Pigmentirung der Choroidealsarkome." Mit Taf. XX und XXI. Fig. 1-9.

"Ein weiteres Beitrag zur Lehre von den Leucosarkomen der Choriocapillaris." Mit Taf. XIV. Fig. 1-2. Arch. f. Ophth., 48, 2, pp. 319-327, 1899.

"Gibt es wirklich Leucosarkome des Uvealtraktus?" Ber. der ophth. Gesellsch. zu Heidelberg, pp. 173-184. 1905.

"Zur Frage des Vorkommens von Eisenreaktion in Melanosarkomen der Choroidea." Beitrage z. path. Anat. u. allg. Path. Suppl.—Heft., 1905.

"Das Melanosarkom des Uvealtraktus in seinen verschiedenen Erscheinungsformen." Mit. Taf. VIII, Fig. 1-9. Arch. f. Ophth., 60, 1, pp. 377-400, 1905.

"Das Melanosarkom als einzige Sarkomform des Uvealtraktus." Mit. 35 Abbild. im Text u. 18, Fig. auf Taf. 1-111. 131 pages. Wiesbaden.

[4] Lagrange: "Traite des tumeurs d' l'oeil." Bd. 1. Paris, 1901.

[5] Riecke, A.: "Ueber Formen und Entwickelung der Pigmentzellen der Choroidea." Mit Taf. IV, Fig. 1-9. Arch. f. Ophth., 37, 1. Pp. 62-96. 1891.

All these various stages are reproduced in the cells found in the so-called leucosarcoma, according to Schieck; but he makes one modification of Ribbert's teaching, namely, that the reversion of the branched cell to the widely different round cell is not a necessary stage, and only a possible one in any case. He agrees with Fuchs[6] that sarcoma of the uvea may proliferate directly from a highly developed type of uveal cell; thus we may have a spindle-cell sarcoma in which round cells are not present and never have been present. Indeed, a pure round-cell sarcoma of the uvea has never been described. Ribbert[7] says, however, that he does not doubt that a wholly unpigmented, round or spindle-cell chromatophore sarcoma can occur.

The view that the round cell develops into the spindle cell and the spindle cell into the star-shaped cell has been criticised by Borst,[8] who says he has not seen anything to lead him to believe that the cells of one stage go over into those of another stage. Even though this is true, it does not seem to me that it in any way vitally affects the chromatophore theory. Why may we not suppose that some adult cells revert to the epithelioid stage, others to the spindle-cell stage and still others to the stellate-cell stage? Such a conception would accord well with the teaching of Flexner[9] that the various cells found in glioma represent only variously differentiated types of embryonal neuroglia; thus astroblasts give rise to small round-cell gliomas, simulating sarcomas, ependymal cell proliferations give rise to neuroepitheliomatous gliomas, the astrocytes proliferate in spider or Dieter's cell gliomas, and adult neuroglial tissue is reproduced in the type of tumors made up largely of fibers. It is interesting to note in this connection that neither Flexner nor Schieck have actually encountered pure round cell gliomas or sarcomas, which they consider the most embryonal type, although they both speak of them as possible forms.

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[6] Fuchs, Ernst: Ber. der Ophth. Gesselsch. zu Heidelberg (discussion); p. 183, 1905.

[7] Ribbert, H.: "Geschwulstlehre," p. 256, Bonn, 1904.

[8] Borst, Max: "Die Lehre von der Geschwuelsten," vol. i, p. 154. Westbaden, 1902.

[9] Flexner, Simon: "Glia and Gliomatosis." Jour. of Nervous and Mental Disease, vol. xxv, pp. 306-309. 1898.

On the other hand, I can find nothing in Riecke's article to bear out Schieck's inference that the round cell is the first and most rudimentary stage of the chromatophore in the embryo. Riecke's statement (p. 75) is, as given above, to the effect that one first finds spindle and star-shaped cells in the seventh month of fetal life; round cells are not mentioned. Schieck[10] states that Riecke's findings agree throughout with his own study of a series of embryonic choroideæ, and then says in his summary (p. 72): "Therefore the stage of the unpigmented cells precedes that of the pigmented cell and the round and spindle cell that of the branched cell." I contend that it has not yet been definitely proved that there is a round cell embryonal stage. Just this point seems to me to be of great moment for the whole theory, because we frequently encounter areas of small round cell proliferation in uveal sarcoma.

Degenerative changes in the chromatophores have been given careful study. The pigment granules lose their even distribution throughout the cell body, nucleus and processes, and group themselves together in clumps; at the same time the processes either lose their connection with the cell body, or, what is more probable, undergo contraction into the body, thereby increasing its volume and making it more spherical. The nucleus of a "ripe" chromatophore stains normally after the cell has been depigmented, but in the "over-ripe" stage the nucleus scarcely stains at all, or has disappeared entirely along with the whole cell; thereon the pigment-heaps keep the spindle or star-form of the cell for a while, and then become diffused through the tumor. Normal chromatophores do not give the iron reaction, but as soon as the pigment begins to clump the iron reaction is present; clumping of the pigment therefore is an index of cell death.

All of the cases studied to date have been sarcomas of the choroid; indeed, few cases of leucosarcoma of the iris have been described in the literature, and none of them studied with respect to the chromatophore theory. I therefore take the liberty of presenting three cases of leucosarcoma of the iris for special consideration in the light of the chromatophore theory.[11]

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[10] Schieck (1906): Loc. cit.

CASE 1.—O. J. M., aged 41. I am indebted to Dr. W. A. Barr for the privilege of studying this eye; it was removed for sarcoma some three months subsequent to the appearance of the tumor; there had been three hemorrhages into the anterior chamber within the two years previous.[12]

*Unstained microscopic sections*, submitted therewith, show one entire half of the iris to be the seat of a lens-shaped tumor 3 mm. long in the plane of the iris, and 1.5 mm. broad from before backward. Although the sinus angle is completely blocked and the canals of Schlemm invaded, yet the adjacent cornea and ciliary body are not encroached on. No discoloration by pigment can be seen with the naked eye or by the loupe.

*Microscopic examination* shows a highly vascular, alveolar, small spindle-cell sarcoma completely replacing every vestige of the body of the iris, including its normal vessels and stroma pigment cells (Fig. 1). Each alveolus, of which there are ten to twelve from pupil to iris root, is bounded by a narrow, incompletely closed connective tissue band representing obliterated or still patent blood vessels; in nearly every instance a few red cells can be seen along these bands. There is no rosette formation or palisade arrangement of cells about vessels or alveolar septa, and nothing to suggest that the cells originate in the endo- or perithelium. The cells are nearly all fusiform in shape and arranged in densely packed bands and trains with very little intercellular substance. Their nuclei are oval spindles 3 by 4.5 to 3 by 12 microns in size, with a sharp, heavy staining outline and a clear, distinctly granular central portion containing one or more nucleoli. In the older, less heavily staining alveoli toward the back part of the iris the cell bodies are more quadrilateral in shape and give off processes from their angles; more often these processes are developed from the opposite poles of spindle cells.

In striking contrast to the apparent lack of pigment noted in the examination by the loupe, one now finds that nearly every alveolus, and all the vessel-bearing septa between them, contain spindle shaped and branched pigmented chromatophores. These are best studied in alveoli which contain only three or four of them, as shown in Figure 2.

Under the oil immersion they present a beautiful picture, reproducing all the features of the delicately branched, physiologic chromatophores, except that they contain either more intensely pigmented granules, or many times more granules

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[11] The clinical and anatomic aspects of all these cases will be more fully reported at a later date.

[12] Shown before the Chicago Ophthalmological Society, May 10, 1904. (See Ophth. Record, vol. xiii, p. 376, August 1904.)

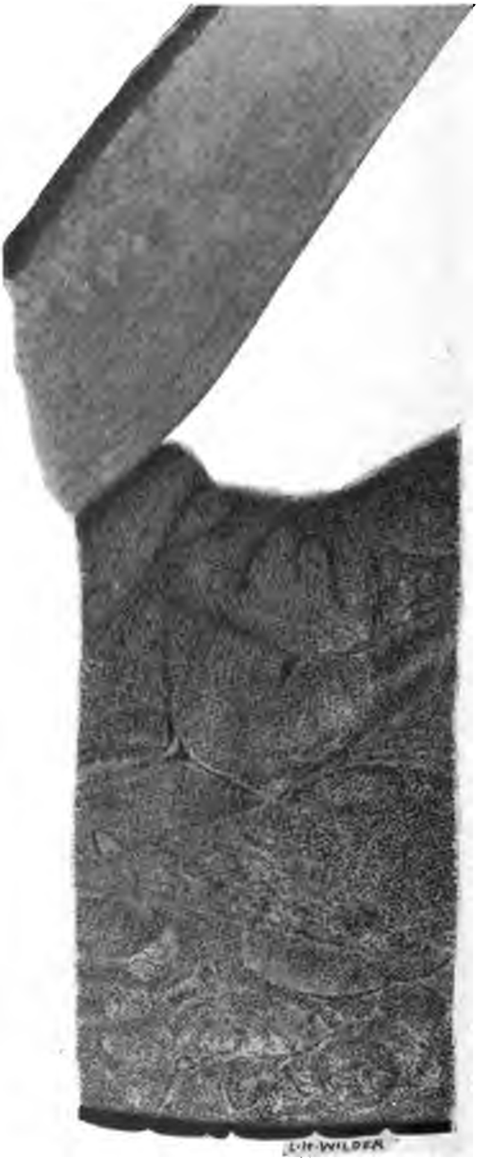

Fig. 1.—Case 1. Leucosarcoma of the iris (Leitz obj. 1/3 oc. 3).

than I can find in any normal stroma cells. This, to my mind, makes it extremely improbable that they are remains of normal cells, as maintained by Lagrange in leucosarcoma of the choroid. Of course, the iris stroma cell is much less intensely pigmented than is the choroidal cells, and the contrast between normal and proliferated chromatophores in the iris correspondingly greater than in the choroid. The fact, too, that all the normal iris vessels have disappeared makes it almost inconceivable that such delicately branched cells could persist in the face of such pressure. Aside from well-formed, finely granular, pigmented cells, the whole tumor is more or less permeated by formless mass and clumps of pigment, much of which is evidently migrated epithelial pigment. But again, the groups often have a fusiform-cell shape; these represent end stages of over-pigmented chromatophores, because the clumps give the iron reaction, while the finely granular, pigmented, intact chromatophores do not.

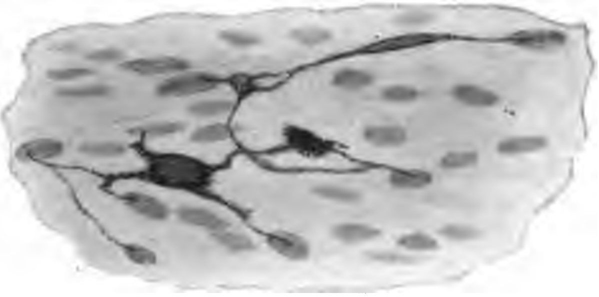

Fig. 2.—Case 1. Four anastomosing, branched, pigmented chromatophores surrounded by pigmented tumor cells (1/12 in. oil immersion).

The case, therefore, while clinically a leucosarcoma, is in reality made up of proliferating, pigmented chromatophores, i. e., cells with oval-spindle shaped, sharply contoured and distinctly granular nuclei, and finely and intensely pigmented, branched chromatophores.

Case 2.—Mrs. N., aged 42, from the private practice of Dr. J. B. Loring, through whose kindness I am able to present this case. In August, 1904, the right eye of this patient was to all appearances normal, but when she returned three months later an oval, smooth, milky white, intensely vascular, slightly prominent growth, some 4 to 5 mm. across, was seen springing from the temporal root of the iris and ligamentum pectinatum. The eye was promptly enucleated.

*Unstained sections*, exhibited herewith, seen with the naked eye or loupe, show a lens-shaped tumor mass 5 mm. wide from side to side and 2 mm. thick, occupying the outer two-thirds of the iris and the adjacent internal half of the ciliary body. It seems to be entirely without pigment and of the same color reflex as the neighboring cornea and sclera.

*Microscopic study* shows the tumor to be a highly vascular, alveolar, spindle-cell sarcoma, originating from the anterior endothelium of the iris and involving the canals of Schlemm and forepart of the ciliary body by extension (Fig. 3). The tumor is evidently of much more recent growth than in Case 1. One can count twenty-five or thirty vessels in cross section; their walls are thickened and the lumina narrowed or obliterated, all out of proportion to the findings in the vessels of healthy half of the iris. Most of the blood is supplied to the tumor by wide, new-formed vessels. Here, as in the previous case, there is apparently no relation between these vessels and the tumor cell proliferation. Alveolar septa are much less

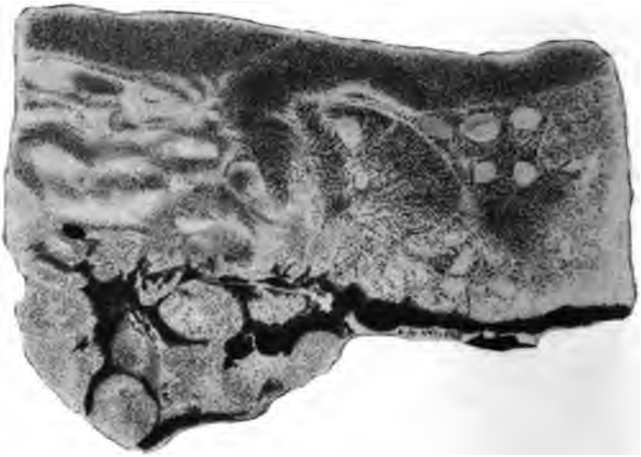

Fig. 3.—Case 2. Leucosarcoma of the iris (Leitz obj. 1/3, oc. 3).

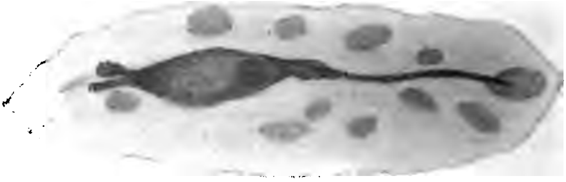

Fig. 4.—Case 2. Incompletely pigmented, bipolar, spindle-cell chromatophore occurring in a wide field of unpigmented chromatophores (1/12 in. oil immersion).

numerous. The oval and spindle form nuclei again show the sharp contour and plain granulation of chromatophores. Spindle-form and star-form branched, pigmented chromatophores are numerous; one with incomplete pigmentation is drawn in Figure 4. Many of them are intensely pigmented. This is in marked contrast with the stroma cells of the healthy half of the iris, among which there are but four pigmented cells aside from those proliferating in a metastasis to the surface endothelium. Considerable pigment detritus is strewn about among the cells, but it is evidently from the retinal pigment epithelium because none of it gives the iron reaction; the

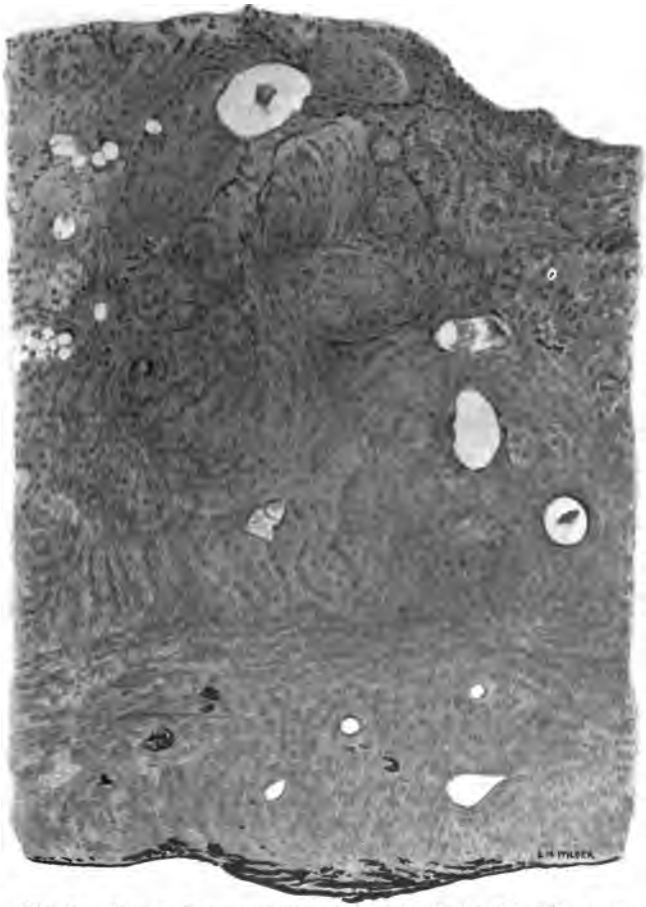

Fig. 5.—Case 3. Leucosarcoma of the iris (Leitz obj. 1/3, oc. 3).

chromatophores likewise do not stain, probably because, the tumor being so young, none of the cells have died.

While, then, Case 2 is clinically a leucosarcoma of but three months' duration, it already shows a large number of proliferated, pigmented chromatophores.

CASE 3.[13]—William D., aged 41, from services of Dr. H. W. Woodruff at the Illinois Eye and Ear Infirmary, to whose courtesy I am indebted for the history of the case. The patient has noticed a cloud before his eye during the past two months; examination reveals a pinkish, gelatinous, translucent, conelike 2.5 mm. elevation seated in or on the iris near the lower, outer, pupillary border between axis 320 and 350 degrees. A single vessel is seen running through the center of the tumor. The diagnosis of leucosarcoma was made after the exclusion of tuberculosis by the tuberculin test, and of syphilis by the therapeutic test. A broad strip of iris 6 by 4 by 2 mm. was then excised.

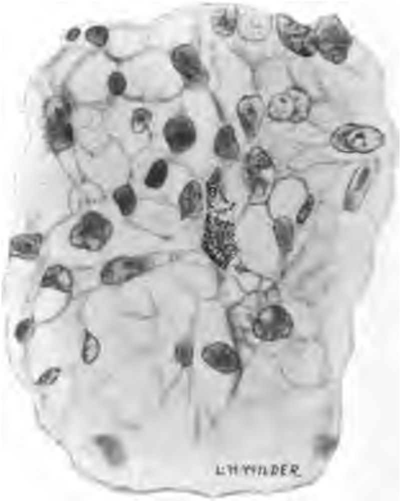

Fig. 6.—Case 3. Fully pigmented, angular chromatophore in a very broad area of unpigmented chromatophores. The processes have disappeared (1/12 in. oil immersion).

*Macroscopic examination* showed a soft pultaceous mass, bordered by the posterior pigment epithelium.

*Microscopic study* of some thirty-five serial sections, 5 microns thick, showed an oblong tumor, about three times the thickness of the iris, situated near the pupillary border, sharply separated from the cut root-edge by a wide zone of healthy tissue. The tumor is a vascular, alveolar, oval-spindle cell sarcoma developing from the anterior part of the iris. The nuclei are sharply contoured and contain tiny nuclei and numerous chromatin granules. The cells, although closely packed, are everywhere separated from one another by a large amount of delicate fibrillar substance, made up for the most part of cell processes. In addition to this supporting structure the mass is subdivided into twenty or thirty rounded alveoli from which a connective tissue meshwork is given off among the adjacent cells. Branched spindle cells and typical pigmented chromatophores are not numerous, yet unmistakably present. One is shown in Figure 6.

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[13] Shown before the Chicago Ophthalmological Society, Oct. 10, 1905. (See the Ophth. Rec., xiv, p. 604, December, 1905.)

The specimen from Case 3 contains pigmented and unpigmented chromatophores, although a growth of but two months' duration and only a couple of millimeters in size, and is therefore a melanosarcoma histologically.

In conclusion, I would recapitulate as follows:

1. Ribbert's theory of the origin of all uveal sarcomas from chromatophores is worthy of most careful further consideration.

2. The analogy between the round, spindle and star-formed cells, which proliferate in sarcoma, and the spindle and star-formed cells, found in the embryonic choroid, is incomplete, because a round cell first stage has not been proved to exist in the latter.

3. It is more reasonable to suppose that the "cell reversion" takes place to any one of these forms of sarcoma, analogous to the relations which obtain between embryonal and pathologic conditions in glioma, than it is to suppose that lower cell forms are transformed into higher cell forms.

4. So-called leucosarcoma of the iris offers a more favorable opportunity for the study of the chromatophore theory than does sarcoma of the choroid, because here the normal chromatophore is much less heavily pigmented than in the normal choroid, or than the chromatophore in the iris. Pressure, too, destroys the normal cell.

5. The term leucosarcoma should be retained, but used only in reference to the clinical appearance of iris sarcoma.

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# TREATMENT OF PROGRESSIVE ATROPHY OF THE OPTIC NERVE DUE TO ACQUIRED SYPHILIS.

## BY SUBCONJUNCTIVAL AND INTRAVAGINAL INJECTIONS OF SUBLIMATE OF MERCURY.*

CHARLES STEDMAN BULL, A.M., M.D.
NEW YORK.

The treatment of syphilitic atrophy of the optic nerve is a subject which taxes all our patience and ingenuity. So universally unfavorable is the prognosis that the ophthalmic surgeon is ready to grasp almost any means which promises a solution of the problem. All surgical interference with the optic nerve itself, such as incision of the nerve sheath in several places, or elongation of the nerve by stretching, has yielded such imperfect and inconstant results that it can not any longer be recommended and has been abandoned. The same may be said of sympathectomy, which has so recently been vaunted as a remedy for atrophy. The constant current, and even static electricity, have been faithfully tried and have usually proved unavailing. Much has been claimed for the treatment by vibratory massage, but I have never personally known of a case of atrophy which has been permanently, or even temporarily, benefited by this method.

In advanced cases of syphilitic atrophy of the nerve I believe mercury administered internally to be useless, and it may do real injury. Roborant treatment, directed to the general health, in these cases sometimes aids in retarding the degenerative process.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

As we all know, there are clinically several forms of atrophy of the optic nerve: the partial, the total, the stationary and the progressive. The cases of partial atrophy are generally stationary. The instances of progressive atrophy met with in syphilitic patients are the most unfavorable. These cases are always bilateral, and the pupillary disturbance, or loss of reflex action of the iris, is often observed within the first year after infection has occurred, and may, therefore, be regarded as a warning of impending atrophy. It may accompany beginning optic atrophy before the loss of sight is sufficient to explain it. The evolution of an optic atrophy is very irregular, and total blindness is often complete in one or two years, though occurring usually sooner in one eye than the other; and some central fibers may remain intact during the remainder of the patient's life. It is in this small minority of cases that we are prone to attribute the arrest to whatever method of treatment we are at the time employing. It is impossible to say how many of these cases of arrest of the degenerative process are due to the treatment adopted, and a therapeutic effect can only be expected when the optic nerve fibers have been merely compressed by the hypertrophy of the connective tissue framework of the nerve.

### USE OF SUBLIMATE INJECTIONS.

Subconjunctival sublimate injections have been employed in the treatment of optic nerve atrophy by various authorities, but hitherto with but little success.

Darier is probably correct in saying that they are contraindicated for the time being whenever the absorption of the fluid by obstructed lymph-channels is rendered difficult or impossible by a circulatory stasis, for in such cases they are irritating and more harmful that useful. It is going too far, however, to say that as an anti-syphilitic method subconjunctival sublimate injections have a rapid and intense action on specific ocular manifestations at all stages, for in most of the chronic cases of deep-seated eye trouble, notably of the optic nerve, this does not hold true. The statement that the chief contraindication to subconjunctival injections lies in an engorgement of the circumcorneal circle of vessels is true only of the lesions of the anterior parts of the eye, and does not apply to optic nerve atrophy.

The subconjunctival injection of the various salts of mercury is more or less painful, the cyanid being the most so. In endeavoring to prevent or diminish the pain of mercurial injections do not add a solution of cocain to the sublimate solution, for the cocain is decomposed at once. Akoin lessens the pain, but is precipitated by the least alkalinity of the solution. It is better to inject a few drops of a 5 per cent. solution of cocain under the conjunctiva five or ten minutes before the sublimate injection is made. If akoin is used a 1 per cent. solution is of sufficient strength.

Zossenheim[1] has used injections of sublimate in many cases of optic nerve atrophy, but reports not a single case of encouraging results.

Dufour prefers sublimate to cyanid of mercury, of the strength of 1 to 3,000, and never injects more than half a syringeful. He keeps his patient in bed for two days with both eyes bandaged. If there is no improvement after the eighth injection he gives up the treatment.

Senn[2] prefers the cyanid of mercury to the sublimate in cases of optic atrophy, but reports no favorable results.

## METHOD OF TREATMENT.

The principles of subconjunctival injection laid down by Darier would apparently apply only to the anterior segment of the eye, and their effect on the aqueous humor through Schlemm's canal and Fontana's space. If, however, the efficacy of subconjunctival injections depends on the absorption of the injected substances, the moment an isotonic equilibrium is established, there is no reason why this condition may not be induced in the posterior channels of filtration by subconjunctival injections far back of the equator of the eye, and thus an effect be produced theoretically on the optic nerve. These posterior injections must not be made near the limbus, nor too deep under the conjunctiva, where the capsule of Tenon is intimately attached to the sclera. In making the injections it is better first to incise the conjunctiva and separate it for some distance from the sclera by a strabismus hook and then introduce the needle far back, hugging the sclera, and inject slowly. There is less pain from the injection if the episcleral tissue is not injured.

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[1] Deutschmann's Beiträge, vol. xv, p. 41.
[2] Arch. f. Aug., 1904, p. 232.

I use a Pravaz syringe with a fine needle of iridised platinum, which can be sterilized by passing it through a gas flame. The liquid to be injected must be sterilized by boiling and allowed to cool to blood temperature and is then injected. The injection is made in the superotemporal region, tangentially to the sclera, and the liquid must not be allowed to extend toward the limbus. Hence the value of dissecting the conjunctiva from the sclera in the direction backward toward the optic nerve entrance before the injection is made.

This method of treatment was carried out on twenty-five cases of progressive atrophy of the optic nerve, due to constitutional syphilis. They were cases of simple atrophy and were not preceded by any intraocular signs of papillitis or neuritis. They were all private patients under my own care until the treatment was abandoned as useless. They had all been subjected to one or more full courses of thorough anti-syphilitic treatment by skilled syphilologists, which had been carried out for a varying period from one to two years, or until no constitutional symptoms had appeared for some time.

The presence of tabes or disseminated sclerosis was so far as possible excluded.

Before the treatment by subconjunctival injections was begun the patients were subjected to a course of strychnia by hypodermic injections, pushing the dose of the drug to the extreme of toleration. In every case the observations, the testing of the vision and the visual field were made by myself. Some of the cases had been previously treated by the interrupted current and by static electricity by other physicians, and two of them had undergone a prolonged treatment by vibratory massage without any benefit.

The shortest interval between the occurrence of the initial lesion and the first failure of vision was two years, and the longest interval was twenty-three years. From investigations made by Januskiewicz, covering many cases, it has been found that the shortest interval in any reported case between the contraction of the disease and the failure of vision was six months, and the longest was twenty-nine years. The failure of vision occurred most frequently from five to ten years after the appearance of the chancre.

## RESULTS OF TREATMENT.

In none of the cases was there any permanent improvement of the vision by the treatment noted, and in only three was there any temporary improvement. In no case did the injections cause any acceleration of the loss of sight.

In three cases, besides the subconjunctival injections, an intravaginal injection was made directly into the sheath of the optic nerve. For this purpose the tendon of the external rectus muscle was divided, sutures were introduced through the tendon so as to allow of its reattachment to the eyeball, and the muscle was then drawn upward and outward away from the wound. The conjunctiva was then carefully separated from the sclera as far as the apex of the orbit by strabismus hooks, and the optic nerve was drawn forward by a blunt hook. The sheath of the nerve was then grasped by a pair of fine forceps and lifted up, and the needle was pushed through the sheath parallel to the nerve, and the injection was made. The tendon of the muscle was then stitched to its former line of attachment to the sclera, the conjunctival wound was closed by a suture, and both eyes were bandaged for two days.

The vision existing in the two eyes of the several cases at the time the treatment was begun varied from light perception in both eyes as the lowest to 15/200 in both eyes as the highest. The injections were made at intervals varying from one week to every second day, and in the cases in which both eyes were seriously affected the injection was made in one eye, and at the next visit in the fellow eye. If there was no improvement after the tenth injection the treatment was abandoned. The drug used in every case was a solution of sublimate, beginning with 1 to 5,000 and increasing the strength of the solution to 1 to 2,000. The first injection consisted of 10 minims, and the dose was gradually increased until 20 minims were injected, and this dose was never exceeded. Each injection of the sublimate was preceded by an injection of 5 minims of a 5 per cent. solution of cocain, and in this way the pain was reduced to a minimum, and never lasted more than 5 or six minutes, and was characterized by the patient as a burning sensation. After the injection the eye was not bandaged, but cold applications were made to the eye until the burning sensation subsided. In no case was the injection followed by any marked signs of irritation, and the swelling of the subconjunctival space rapidly subsided under the influence of the cold applications.

The temporary improvement in the vision in three of the cases lasted but a short time. In one case, a man, aged 46, the left eye was entirely blind, while the right eye V.=5/200. After the sixth subconjunctival injection and one intravaginal injection the vision rose to 15/70 and remained so for five weeks. It then slowly grew worse, and in three months from the date of the last injection it was reduced again to 5/200. In the second case of improvement, V.=15/200 in each eye. After the sixth subconjunctival injection and one intravaginal injection in the right eye the vision of the right eye rose to 15/50—the left eye remaining unchanged; but the improvement lasted only four weeks and then rapidly sunk to 15/200. In the third case of improved vision the right eye was entirely blind and the left eye could count fingers at three feet. After ten subconjunctival injections and one intravaginal injection in the left eye the vision of the left eye rose within a few hours from counting fingers to 15/70 and the field was perceptibly widened. This patient lived in Texas and returned home two weeks after the last injection. He reported that the improvement of vision lasted four months and then rapidly subsided, so that three weeks later it was reduced to perception of light.

## CONCLUSIONS.

1. Posterior subconjunctival injections of sublimate may be given with but little pain if the sublimate injection is preceded by the injection of cocain.
2. The conjunctiva should be incised and carefully separated from the episcleral tissue, and the injection made far back toward the apex of the orbit.
3. The eye need not be bandaged after the injection, but cold applications should be made for half an hour.
4. This method of treatment of cases of atrophy of the optic nerve has, in my hands, proved of no more value than the usual routine treatment by mercury, potassium iodid and strychnia, and offers no encouragement for its continued use.

CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# PARAFFIN PLATES AS AN AID IN OPERATIONS FOR EXTENSIVE SYMBLEPHARON

## AND FOR THE RESTORATION OF CUL-DE-SACS FOR PROTHESIS.*

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Symblepharon of severe degree, because of extensive destruction of the conjunctiva, has long been a *bête noir* for the ophthalmic surgeon. I do not intend to consider in this paper those simpler cases in which there is a limited destruction of the conjunctiva and slight band-like adhesions between the eyelid and the ball, for these can easily be relieved by the exercise of some ingenuity on the part of the surgeon and the transplantation of flaps of conjunctiva by one of the many methods that have been devised by different operators. I propose, however, to consider those severe cases in which, from injury, burn or ulceration, there has been extensive destruction of the conjunctiva, and a great part or the whole of one or both lids has become firmly adherent to the eyeball.

My subject also includes those more difficult cases of atrophy of the conjunctiva, sometimes almost total, resulting from ulceration, burn, cicatricial growth in the orbit from cellulitis after an imperfect operation of enucleation, in which an artificial eye can not be worn and which are brought to the surgeon for prothesis. Such cases of total symblepharon have been a dread to every ophthalmic surgeon, and, as stated by Arlt years ago, are for him a *noli me tangere.*

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

Knapp[1] stated:

> In spite of the numerous attempts which, during the last twenty-five years, have been made to remedy this unfortunate condition by grafting skin or mucous membrane of all possible localities and in all possible manners on the atrophic surfaces, I have not seen, either in New York or in my travels, a single case that had been more than a temporary improvement, including even the cases in which the object aimed at was only to fit a stump for the prothesis of an artificial eye. All these grafts, if they take root at all, sooner or later ulcerate and slough or shrink to nothing.
>
> The older methods of securing free space by putting between the wounded surfaces foreign bodies, e. g., plates of metal, have been abandoned.
>
> The grafting of small pieces of skin or mucous membrane on wounded surfaces had practically to be given up when tried on the conjunctiva. The unavoidable movements of the eye almost always prevented them from taking root.

I make this rather extensive quotation from such an eminent authority as Dr. Knapp to show that as late as 1898 the application of grafts for the purpose of making an artificial fornix was unsuccessful, and the same was said of transplantation of skin flaps from the lid or cheek.

The reasons for failure are apparent. Thick-skin grafts, such as Wolff grafts, are more likely to slough than the thinner Thiersch grafts. Again, the latter are not likely to grow unless they are perfectly and evenly applied to the wound surface, and this is accomplished with difficulty in the case of a cul-de-sac or fornix that has to be lined unless we use some means that insures perfect and even coaptation. This is not accomplished by the use of sutures placed through the graft and fornix, for these tend to wrinkle it, but such sutures may have a distinct advantage if used according to the method practiced by Weeks,[2] so that they will pass through the firm tissue of the periosteum in their course to the cheek and so anchor the graft firmly and reduce to a minimum contraction of the new fornix.

The ideal operation for symblepharon will be that which will bring about permanent restoration of the fornix and secure mobility of the eyeball, or, if the eyeball is absent, furnish a cul-de-sac deep enough to allow an artificial eye sufficiently large to be worn. This ideal operation must remove any cicatricial tissue that causes thickening and deformity of the lid, or that would by its contraction cause shrinking of the newly made cul-de-sac.

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[1] Norris & Oliver: "System of Diseases of the Eye," vol. iii, p. 884.

[2] Weeks: Trans. Sect. on Ophth., A. M. A., 1902. Trans. Tenth Cong. Ophth., Lucerne, 1904.

The new cul-de-sac must be lined with epithelium, and for this purpose one would preferably select conjunctiva if that were available, but this is not easy to obtain, although for operations of limited extent the conjunctiva of a rabbit or a dog may be used.

In this particular we can not attain our ideal and are forced to take epithelial structure from some other part. Mucous membrane from the lip may be used, but here again the amount is limited and it is difficult properly to sterilize it and to remove it in thin layers, such as are required. Furthermore, such grafts are more liable to shrink than those taken from skin surfaces.

The lining graft should be thin and membrane-like, and so if mucous membrane is not available Thiersch grafts of suitable size may be used instead. These, as originally pointed out by Hotz,[3] answer almost every requirement, although, naturally, there are some objections to their use. The membrane must be perfectly fitted to line the pocket and must not wrinkle or fold, but must be perfectly coapted; otherwise it will not attach itself and will slough away. The introduction of some mechanical appliance, such as a plate, that will press the graft evenly and firmly into every part of the new cul-de-sac, and will at the same time immobilize the part, so that healing will take place promptly, a plate that can be easily removed if desired and as easily replaced, that will not irritate by its presence; such a method would approach the ideal.

A number of years ago, before the introduction of plates for this purpose, I tried in several cases to hold the graft smoothly in place by pouring melted paraffin into the freshly lined pocket, but the paraffin had to be of such low melting point to avoid injury to the tissues that it was not firm enough to give the needed support. In some simpler cases it seemed to suffice, but it would not meet the requirements in the more difficult ones. I made mention of my experience with this method a

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**3. Hotz: "The Use of Thiersch Skin Grafts as a Substitute for Conjunctiva," Ann. Ophth., April, 1893.**

number of years ago in a discussion on this subject in this section, but I have since abandoned its use.

Nothing answers so well the purpose of holding the graft in position as some form of plate. In 1898 Morton[4] recommended the use of a prothesis to hold the grafts in place, and a little later May[5] contributed reports of several cases successfully treated by this method. He uses a shell of porcelain or glass, shaped like an artificial eye, on which the Thiersch graft, with its raw surface outward, is placed. This shell is then placed in the newly made cul-de-sac, so that the raw surfaces are brought into contact. Fine sutures unite the edge of the graft with the edge of the wound.

A number of operators have reported satisfactory results in operating for total symblepharon by implanting Thiersch grafts and holding them in place by a glass or porcelain prothesis after the method of Morton and May. Among these are Natanson,[6] Grunert,[7] Gullstrand[8] and Abadie.[9]

Weeks recommends a plate made of "base gutta percha" about 1 mm. thick, such as is used by dentists, which is molded into proper form after dipping it into hot water. The Wolff graft that he uses is secured by loop sutures that pass through the firm periosteum at the orbital margin, and is then held in place by the gutta-percha plate.

Hotz[10] employs a lead plate (Fig. 1) that is shaped to fit the new cul-de-sac. The Thiersch graft is first spread out over the wounded surface and the edges united with fine sutures. After this is accomplished the lead plate is placed in position and stitched to the lid through holes previously drilled through the plate. This holds the graft down into the deepest part of the cul-de-sac.

H. W. Woodruff[11] employs much the same method, preferring, however, to make the plate of block tin. He spreads the graft over the edge of the plate, raw side outward, and then inserts it carefully into the new cul-de-sac. He does not attempt to suture the edge of the graft to the conjunctiva (a manifest advantage if it can be dispensed with), but in sewing the plate to the lid he passes the thread through that part of the graft that lies next to the lid. Only one lid is operated on at a time.

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[4] Morton: Ophth. Rec., Aug., 1898.

[5] May: Arch. Ophth., vol. xxviii, p. 182, 1899; vol. xxx, p. 474, 1901.

[6] Natanson: Klin. Monats. f. Augenhk., vol. xlii, p. 116.

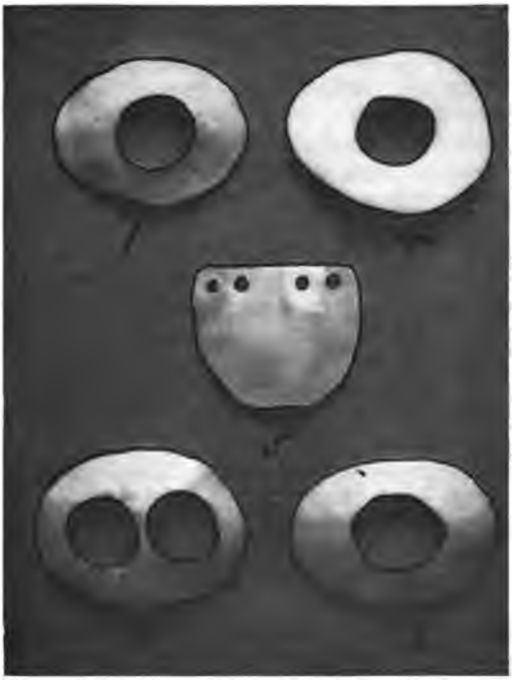
[7] Grunert: Klin. Monats. f. Augenhk., vol. xliii, p. 298.

[8] Gullstrand: Klin. Monats. f. Augenhlk., vol. xliii, p. 312.

[9] Abadie: Bull. et Mem. de la Soc. Franc. d' Ophth., vol. xx, 1903, p. 241.

[10] Hotz: Klin. Monats. f. Augenhlk., vol. xliii, p. 319, Chicago Med. Rec., 1901; Ann. Ophth., July, 1905.

[11] H. W. Woodruff: Ann. Ophth., March, 1903.



**Figs. 1 and 3.—Lead plates prepared for symblepharon operation, the cornea being present.**
**Fig. 2.—Lead plate used for restoring cul-de-sacs for prothesis. This would be coated with paraffin.**
**Fig. 4.—Similar plate coated with paraffin.**
**Fig. 5.—Lead plate to be sewed to the lid in the method of Hotz and Woodruff.**

I have seen the results of some of Dr. Woodruff's operations and can testify to the value of the method. Indeed, his success prompted me to endeavor to add something to the technic of this difficult work.

The method of operation that I now employ, a modification of the plate or prothesis method, has proved so successful in my hands in a number of difficult cases that I venture to recommend it. Metal plates, preferably of soft sheet lead or block tin that can be easily cut to any size or molded to any shape, are coated with hard paraffin of high enough melting point so that the temperature of the body will not melt it and so expose the metal plate. Such a paraffin plate is perfectly smooth and can do no harm to the cornea.

Through the center of the plate a hole about the size of the cornea has been made, and through this the cornea can be seen and treated if necessary while the plate is in position (Fig. 1).

In operation on cases of obliteration of the conjunctival sac, the eyeball being absent, I use a paraffin plate of a size large enough to fill out both cul-de-sacs, and in the center of this plate have two or three holes, through which the orbit can be easily irrigated while the plate is in position. Furthermore, the band of metal separating these openings furnishes a good handle for the forceps to seize while inserting or removing the plates.

## TECHNIC.

The technic of an operation for symblepharon of one or both lids when the eyeball is present and the cornea is intact or partially so would be as follows: In many cases local anesthesia will suffice. In addition to 4 per cent. cocain solution externally, hypodermic or subconjunctival injections of 0.5 per cent. solution are used. In extensive cases or with nervous individuals a general anesthetic would be required.

If the palpebral fissure is shortened, a free canthotomy should first be made, extending to the orbital margin to give a free field for dissection. The lid should then be carefully dissected from the cornea, if it is attached thereto, and this can best be done with a Graefe cataract knife. In the course of the separation of the lid from the eyeball and the preparation of a new cul-de-sac the dissection should be made close to the lid and should proceed until the margin of the orbit is reached, if there is much cicatricial tissue present. Unless the dissection is close to the tarsus the lid is apt to appear too thick; this precaution, therefore, is especially to be observed in restoration of the socket for prothesis.

If the margin of the lid has been destroyed, as by a burn, an attempt should be made to restore it by inverting the part dissected from the eyeball, and by loop sutures passed through it, "hemming" it in a position to secure proper continuity of the lid border. This can sometimes be very accurately done, as in a difficult case of symblepharon I recently had in which two-thirds of the lower lid border changed into scar tissue because of a burn with molten iron, had grown to the eyeball, covering the lower half the cornea.

In preparing such a flap for inversion, care should be taken to make it thin enough by dissecting off the cicatricial tissue with knife or scissors.

When the cul-de-sac has been made of the proper depth and the eyeball is free to move in all directions, the operator proceeds to fashion a prosthetic plate. For this purpose pure sheet lead about 0.5 or 1 mm. in thickness is preferred, for it is easily shaped with scissors, knife and file, and is soft enough to mold into any form to suit the individual requirements. The part that is to hold the graft in the new cul-de-sac may be made of more prominent contour to insure a greater depth at this point. As the piece has been properly sterilized, it can be introduced into the wound to be sure that it will fit. A large circular opening for the cornea is then made with knife or drill and its edges made smooth with a round file. After being cleansed and dried, the plate, held by its edge with light forceps, is dipped quickly in melted paraffin, which has previously been sterilized by boiling.

As has been said before, this paraffin should be hard, with a melting point not lower than 130 F. The thin layer that adheres to the metal can be quickly set by dipping it into cold water, and then it can be repeatedly dipped into the paraffin and into the water until it has an even coating of the proper thickness. The vessel containing the melted paraffin should be in a dish of hot water to prevent congelation; otherwise the layer of paraffin deposited will be too thick and uneven. A very short time is required to prepare such a plate.

A thin Thiersch graft should then be cut from the least hairy part of the arm or leg. It is well to have the graft wide enough so that one piece will answer for each lid and there will not be too much overlapping. The razor that is used for cutting the graft should be in the best possible condition and should be flat on one side, like that used for histologic section cutting. A very little vaselin or soft-soap rubbed on the flat surface of the razor prevents it from sticking to the skin and so insures a more even graft as the surgeon cuts it with short sawing motions. An assistant keeps the razor and graft flooded with warm salt solution.

The graft is transferred to the paraffin plate directly from the razor by setting that edge of the plate which is to rest in the new cul-de-sac against the epithelial side of the graft which is uppermost, and then stroking it into place with forceps or spatula, so that both sides of the plate are covered. The graft is very easily handled, as it adheres beautifully to the paraffin surface, and every wrinkle can be smoothed out or the position can be changed as desired. This adhesion of the graft to the paraffin, preventing the curling of the edges, which is so annoying, and making unnecessary the use of any sutures, is one of the advantages of the method.

The plate now covered with the graft, the raw side outward, is inserted into the new fornix, the hemorrhage, of course, having been checked. The graft naturally comes in contact with every irregularity of the raw surface of the cul-de-sac and should be large enough to lap over on the uncut surface. No sutures or trimming are necessary, for the overlapping edges will either be cast off or can be trimmed off later at the time of one of the dressings, and if care has been taken in fitting and coating the plate and applying the graft smoothly to it all raw surfaces will be covered.

If the symblepharon affects but one lid there will be very little danger of dislodgment of the graft when the operator inserts the paraffin plate, if he first presses it into the new cul-de-sac and then draws the sound lid over it. If both lids are involved it would be better to avoid displacing the graft on one side of the plate by securing it with two or three sutures, which can be passed through the edge of the graft and then through the openings in the plate to the edge of the graft on the other side. This can very easily be done, as the graft adheres so well to the paraffin. It is almost needless to say that during the manipulation of the graft on the plate an assistant should keep it warm and moist with saline solution. In this way both lids can be operated on at the same session.

If a canthotomy has been done, the canthus should be brought together with sutures, and then a moist boric-acid dressing of gauze and cotton should be placed over the closed lids and held in place with an appropriate bandage. Both eyes should be bandaged and the patient kept in bed. The dressing may be changed the next day so that the cornea may be inspected and the eye gently irrigated with a warm boric-acid or saline solution.

If the case is one in which the eyeball is present, the plate is carefully removed at the end of forty-eight hours to make sure that the cornea is uninjured and that the paraffin has not been rubbed off the plate. The graft will be attached by this time, but after gentle irrigation the plate should be reinserted and the eyes dressed as before.

In cases of restoration of the cul-de-sacs for prothesis in which the eyeball is absent, the plate may be left in position for six or seven days, if there is no evidence of infection, and the orbit irrigated through the openings in the plate. At the end of this time it should be removed, recoated with paraffin, if necessary, and reinserted. If the plate used in such a case has been very large, to insure deep cul-de-sacs, it may be necessary to cut it in two to remove it easily, but this can be readily done with scissors along a central line corresponding to the long axis of the palpebral fissure. A smaller plate can be reinserted or the old one can be reapplied by hinging it, that is, making holes at either end of each half and tying them together with strong silk thread. In cases in which there has been extensive contraction of the conjunctiva, such plates must be worn continuously for weeks to prevent shrinking of the new cul-de-sac.

I have operated by this method in eight severe cases of symblepharon, two of which were total, and with uniformly good results. Six of these cases had extensive symblepharon of the lower lid, so that the cornea was partly covered by the adhesion and the eyeball could not be moved. The patients wore the paraffin plate over the cornea with perfect safety and comfort until the graft had firmly healed in place and good mobility was secured. In the cases of total symblepharon there was complete obliteration of both cul-de-sacs, in one of them the palpebral fissure being reduced to a mere slit. In each case operation was done on both lids at one session and the results obtained were such that an artificial eye could be worn. Furthermore, the length of time that has elapsed since the operation, two and one-half years in one case and nearly two years in the other, without noticeably more shrinking than occurred in the first three months after the treatment, encourages me to believe that the result is permanent.

### CONCLUSIONS.

The advantage of a plate for holding mucous or Thiersch grafts in place in the fornix of the eyelids is obvious. The advantage of the paraffin plate is that it can do no harm to the cornea. It can be built up as required to fit any conjunctival cul-de-sac that has to be lined with a Thiersch graft. The graft adheres to the paraffin, so that it can be evenly smoothed out on it, and thus perfect coaptation is secured between the graft and the raw surface of the cul-de-sac. To accomplish this the graft should be thin and large enough to cover all raw surface, no sutures being required. With perfect coaptation the graft will have secured a firm hold at the end of forty-eight hours and the plate can be removed for cleansing the eye. In the case of restoration of the socket for prothesis, it may be left in place for a considerable time, for the sac can be cleansed by irrigation through the holes in the plate. If it is so large that there is difficulty in removing it, it can be cut in two and the subsequent treatment continued with a plate that can be more easily inserted.

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12. Czermak: "Die Augenärztlichen Operationen," 1893-1904.
13. Axenfeld: Klin. Monats. f. Augenhlk., 1900.
14. Noorden: Berl. klin. Wochft., 1891, No. 4.
15. Maxwell: Ophth. Rev., 1903.
16. Gidney: Indian Med. Gaz., vol. xxxix, 1904.
17. Paton: Lancet, 1904, vol. 1, p. 1121.
18. Doyne: Ophthalmoscope, December, 1905.

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may have this origin. In a subsequent article (1901) Otto[3] adds 4 cases of sclerosis of the carotid and ophthalmic arteries the findings in which confirmed the original as to the nature of the atrophy and the varying location corresponding to the position of the affected vessels. In all of these cases, so far as it was possible to determine, related ophthalmoscopic and functional changes were absent.

In 1891 Bernheimer[4] reported two interesting cases. In one the nerve was divided into two unequal longitudinal parts by the pressure of the sclerosed carotid and ophthalmic arteries on its ventral surface. In the second case the optic nerve was furrowed on its *dorsal surface* at the point where the dural sheath begins. He expresses the view later again set forth by Otto. He attributes the absence of clinical symptoms to the fact that in these cases the ophthalmic artery coursed parallel with the optic nerve fibers within the optic canal to its exit into the orbit; and that notwithstanding the marked changes, there could be no influence on the conductility of the nerve. When, however, the ophthalmic artery takes a right angled tangential course relative to the long axis of the nerve, the fibers must be destroyed by the pressure and produce an atrophy corresponding in degree to the depth of the furrow.

In 1902 Liebrecht[5] added 7 similar cases, all studied from an anatomic standpoint. From a consideration of these and the previously reported cases he finds that the most frequent seats of injury to the optic nerve through arteriosclerosis are: first, within the fibrous portion of the optic canal by imbedding of the ophthalmic artery into the nerve parallel to its long axis; the second is at the sharp free margin of the reduplicated dural sheath where it spans the nerve near the optic foramen; (the nerve may be extensively compressed between this fibrous band above, and the ascending carotid below); the third lies midway between the canal and the chiasm, the place where the anterior cerebral artery above, and the carotid below, cross the nerve. He says that as to the functional disturbance occasioned we have no positive evidence but it may be assumed that as the result of injury at the first point we would have either no functional disturbance or an atypically placed scotoma; at the second, an incomplete or a total transverse atrophy of the nerve with corresponding visual defect; at the third, the lesion and the functional disturbance would vary with the relative position of the two vessels. He states that he has found some marked cases of diminished vision with no determinable cause which he would attribute to arteriosclerosis, and details one occurring in a woman 64 years of age where the atrophic process in the eyes had not taken place synchronously. Vision was reduced to fingers at 2m., and the fields were irregularly contracted especially in the inner halves, almost to fixation.

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[3] Arch. f. Augenheilk., vol. xliii, p. 104.

[4] Arch. f. Ophth., vol. xxxvii, p. 37.

[5] Arch. f. Augenheilk., vol. xliv, No. 3.

In 1904 C. S. Bull[6] reviewed the subject and stated that while he had "no certain data corroborated by autopsy......which would transform a theory into a fact he has for years been convinced that arteriosclerosis of the ophthalmic and internal carotid arteries may affect the optic nerve more frequently and seriously than we have hitherto suspected."

The following interesting case of optic atrophy, in which the prodromal symptoms were of a nature to warrant the assumption of arteriosclerosis as the primary cause of the degeneration, is recorded because of the expressed views of the above quoted distinguished observers and as clinical evidence to substantiate them.

Case 1.—Mrs. A. T., aged 43, married; has seven children, all girls. She has had two miscarriages, one occurring between the births of the last two children and one since the birth of the last child.

*History.*—Aside from nasal catarrh and sick headache, which has become much less severe in the past four or five years, she was well until 15 years ago, when she had an attack of grip which left her with nervous prostration and insomnia, requiring the use of hypnotics. About this time she had metrorrhagia which lasted several months. Eight years ago she had a second attack of nervous prostration. Eighteen months ago she began to have attacks of dizziness, accompanied by temporary blindness. The blindness affected both eyes and lasted from five to ten minutes. At first both eyes recovered fully, but later the lower half of the right field would be slow to recover. This tardiness increased until, for a year past, this portion of the field has remained permanently blind. The left eye has been going through the same process, the upper half of the field, however, being slow in recovering.

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[6] Annals of Ophth., 1904.

The visual disturbances occur at irregular intervals but seem more frequent during the menstrual period. The patient's mother died of tuberculosis of the lungs at 38 years of age, her father of heart disease at 50 years of age. She is in good physical condition except for a slight general arteriosclerosis. Dr. T. H. Weisenburg made a neurologic examination and found nothing abnormal.

*Examination.*—Examination of the eyes showed: Irides prompt to light and convergence. Convergence power weak. Slight left hyperphoria. Vision of R. E. 5/6, L. E. 5/6. Fields as shown in the accompanying illustration (Fig. 1).

Ophthalmoscopic examination: R. E., clear media. Disc vertically oval and pallid, especially in the upper half, where it is decidedly atrophic. Central physiologic excavation. The superior branches of the central artery are very markedly contracted with accompanying white lines. The corresponding vein is shrunken but not to so marked a degree. The inferior branch is a trifle smaller than normal, but the accompanying vein is normal. The scleral ring is sharply cut below and to the outside. The presence of arteriosclerosis is distinctly shown by the marked indentation of the inferior vein by the crossing artery (Fig. 2). L. E., media clear. Disc vertically oval and of a much better tint than that of the other eye, although the lower outer half is decidedly gray. The arteries are slightly reduced in size. The veins are also a trifle small, this being especially so of the inferior branch. The scleral ring is sharply cut in and out.

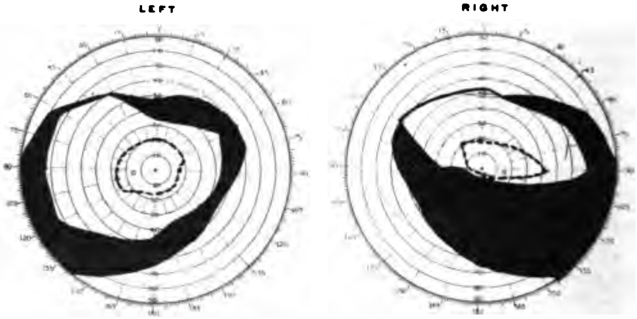

Fig. 1.—Eyefields in Case 1.

*Treatment.*—The patient was given potassium iodid in five grain doses; strychnin 1/30 gr. and nitroglycerin 1/100 gr. three times a day. Pearls of nitrite of amyl were ordered with directions to use them at the onset of the attacks. Two months later she reported having had but two attacks of blindness, both slight as compared to former ones. Four months later she stated that she had had no further attacks

**of total blindness, but had had spells of "swimming of the sight," lasting from three to five minutes, involving the whole field, and recently in the L. E. a sector defect of almost total darkness extending from fixation upwards and outwards, lasting about thirty minutes and disappearing gradually.**

That the theory advanced for the causation of the atrophy in this case shall be upheld, it is necessary that not only should it accord with present conditions but that by it the various remarkable phases through which the case has passed may be satisfactorily interpreted.

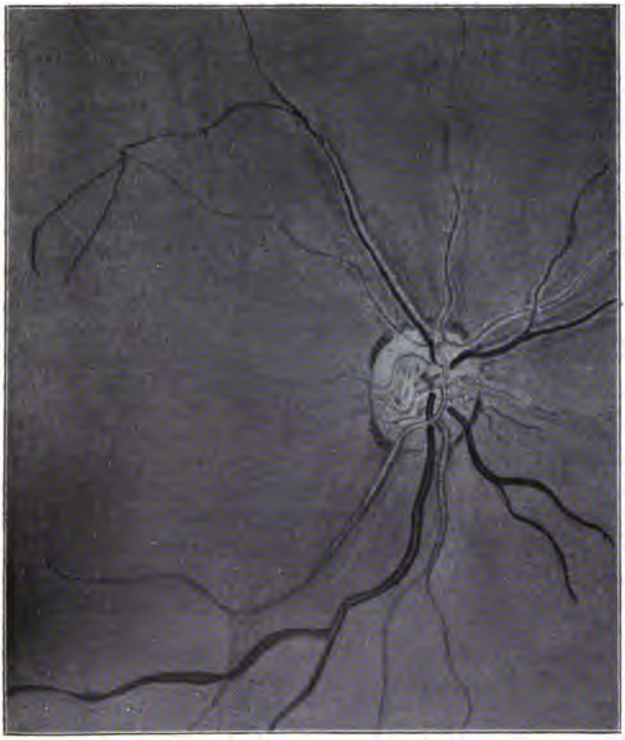

Fig. 2.—Fundus of R. E. in Case 1. Arteriosclerosis shown by indentation of inferior vein by the crossing artery.

As seems well established, in the early stages of arteriosclerosis of the smaller vessels a spasm of the vessels may from time to time occur or during periods of low blood pressure collapse of the vessel may take place.

If this occurred in the ophthalmic artery or certainly if in the central artery of the retina it would produce a transient blindness of the whole field. (It is claimed by some writers that, owing to the free anastomosis between the ophthalmic artery and the branches of the internal carotid, especially the facial, obstruction of the ophthalmic artery could not produce blindness.) This would account satisfactorily for the first symptom.

It has been shown that with sclerosis of the ophthalmic or internal carotid artery pressing the nerve upward against the unyielding edge of the internal end of the fibrous canal a transverse pressure atrophy beginning above and finally involving the entire diameter of the nerve, may occur. This would explain how, later, the vision was slow to recover in the lower field, and finally the blindness in this area became permanent. The advancing atrophy would doubtless at first impede the entrance of blood into this portion of the nerve and its conductility would but slowly recover. When the atrophy became complete and the process crept deeper into the nerve the lower field remained permanently blind. Or it may be that this sluggish return of vision with final blindness in the lower field did not take place until the atrophy had spread forward and squeezed the superior branch of the central artery of the retina. Reference to the illustration will show that the division of the artery has taken place in the nerve so that pressure might readily affect one branch earlier than it did the other (Fig. 2).

## SPASM OF THE CENTRAL ARTERY OF THE RETINA.

As early as 1869 von Graefe[7] recorded an instance of what he termed ischemia of the retina, the diagnosis resting on the presence of contracted arteries and blindness. The condition persisting unchanged for a period of 10 days, operative treatment in the form of an iridectomy on one eye and paracentesis on the other was carried out with a successful result, vision in one eye rising to normal.

In 1866 Rothmund[8] reported having observed the same clinical conditions in two young girls with a like fortunate outcome from operative interference. Somewhat later, in 1874, Loring[9] published a similar case in a man having sclerosis of the aorta and hypertrophy of the left ventricle, in which recurring attacks of transient blindness resulted in permanent loss of sight. He believed that lowering of the blood pressure caused the attacks and that the final total blinding was due to secondary changes in the retina. Five years later Nettleship[10] attributed a similar case to lowered blood pressure.

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[7] Arch. f. Ophth., vol. viii.

[8] Klin. Monatsbl. f. Augenheilk., vol. iv, p. 106.

Berger[11] was one of the first to assign to spasm of the central artery of the retina sudden blindness, he having assumed this to be the cause in a case of a woman 36 years of age, who had left hemicrania and recurring attacks of parasthesia and anesthesia of the left extremities, with blindness of the left eye, associated with pallid nerves and contracted vessels. Iridectomy was performed on the fifth day, with recovery of useful vision. Schnabel,[12], Galezowski[13] and Jäger[14] each report instances of intermittent ischemia of the retina which they laid to spasm. Galezowski's case terminated in thrombosis and atrophy. Schnabel's patient had also glaucoma, and Jäger's was suffering from intermittent fever. Mauthner[15] and Moos[16] believed the cause of visual obscuration in their cases to have been due to emboli. Mauthner supposed the cause to be the lodgment of an embolus in the ophthalmic artery at the place where the central artery of the retina is given off. In Moos' case, besides the retinal disturbance, there was transient diplopia, transient enlargement of the liver, recurring pericarditis, endocarditis and embolism of the mesenteric artery. Walton,[17] Landesberg[18] and Siegrist[19] have observed spasm of the central artery of the retina in migraine; Knies,[20] Klein[21] and H. Jackson,[22] in epilepsy, and Raynaud,[23] Weiss[24] and others, in symmetrical gangrene of the extremities. Barrett,[25] Noyes,[26] Nettleship,[27] Priestley Smith[28] and Posey[29] have all recorded instances of recurring, transient monocular blindness. Posey's cases were not dependent on the other possible causes which he gives for this symptom, namely, ciliary fatigue, glaucoma or migraine. Arteriosclerosis was present and the visual disturbance was assigned to spasm of the vessels. A very significant point brought out by Fischer[30] in his report of 5 cases of transient blindness is that in 45 cases of branch embolism recorded, transient total blindness, lasting from a few minutes to hours, preceded the final permanent limited blindness.

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[9] Am. Jour. of Ophth., 1874. (This and the following footnotes to 24, inclusive, are referred to in Wagenmann's article. Graefe's Arch., vol. xliv, but where possible the abstract was made from the original article.

[10] Brit. Med. Jour., 1897.

[11] Michel's Jahrb., p. 350.

[12] Arch. f. Augenheilk., xv, p. 379.

[13] Rec. d'Ophth., 1882.

[14] Abst. Graefe's Arch., vol. xliv.

[15] Wien. med. Jahrb., vol. ii, 1873.

[16] Virch. Arch., vol. xli, p. 58.

[17] Journal of Nerv. and Mental Diseases, vol. xi, July.

[18] Arch. f. Augenheilk., vol. vii, 1878.

[19] Graefe's Arch., vol. xliv.

With this brief résumé of the cases in which the obstruction was, in nearly all, temporary and in which the cause was likely due, in some instances, to spasm, although this could only be surmised because of the presence of ischemia of the retina and because of the temporary nature of the functional disturbance, a personal observation in which the spasm of the central artery of the retina was repeatedly seen will be recorded.

On Nov. 23, 1905, I was asked by Dr. D. F. Harbridge of Philadelphia (to whom I am indebted for the privilege of reporting the case in abstract) to see the patient whose history follows:

CASE 2.—Mr. C., aged 49, stated that the day previously, while stooping, he noticed some difficulty with the sight of his left eye, and upon closing the right eye he found that the left was blind. The attack of blindness lasted about one minute. That day he had two or three subsequent spells. To-day he had four or five attacks in the forenoon, and between the hours of 2 and 4 p. m., while under observation, he had them as frequently as every half-hour, and they lasted from one-half to two minutes. The obscuration of the field begins in the periphery and is compared by the patient to the shimmer from ice-clad trees or to the movement of biograph pictures. Finally the field becomes totally dark. The clearing up begins in the periphery of the temporal field and with the same accompanying phenomena.

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[20] Bericht. d'Ophth. Ges., 1877 (Arch. f. Psych., vol. xx).
[21] Graefe's Arch., vol. xliv.
[22] Ophth. Rev., vol. iv.
[23] Arch. Gén. de Méd., 1874.
[24] Wien. Klin., vol. 1, 1882.
[25] Ophth. Rev., 1902.
[26] Text-book, 1890.
[27, 28, 29] Posey: THE JOURNAL A. M. A., May 31, 1902.
[30] Fischer: "Uber Emboli des Art. Cent. Ret.," Leipzig, 1901.

*History.*—The patient is a strong, stout man. Covering a period of one year he had severe attacks of vertigo seven years ago. In the spring of 1903 he had an attack of bronchopneumonia, followed by inflammatory rheumatism. Since the disappearance of the vertigo he has become subject to severe attacks of migraine occurring on the average of once in five weeks. Nine years ago he contracted syphilis. He has used liquor and tobacco to excess.

Dr. W. B. Stanton, who examined the condition of the patient's vascular system, states that there is no lung, kidney or heart lesion, but that there is a slight degree of sclerosis of the vessels. Dr. D. J. McCarthy reported that there is a symptom group suggestive of beginning tabes. The patient was given mixed treatment and nitroglycerin. Dr. Harbridge informs me that the attacks have become less frequent but that the optic nerves are becoming quite gray and that the retinal vessels are beginning to show evidences of arteriosclerosis.

*Examination.*—Ophthalmoscopic examination showed a moderate contraction and distinct flattening of the arteries and veins at the onset of an attack of blindness. When the blindness is complete the arteries become ribbon-like and lose their reflex and the veins, especially the superior branch, become very narrow. After a brief period there is a gradual refilling of the arteries and veins, the latter becoming greatly distended, particularly the inferior branch. During the last attack that was observed, the last of a long series occurring at half hour intervals, there appeared to be some retinal haze about the disc. There were never any macular changes. The pupil dilated synchronously with the loss of vision, and for a while after the attack exhibited hippus.

Dr. Harbridge will report the case in detail in *Ophthalmology.*

The opportunity of *repeatedly* observing this phenomenon is probably unique, as a search of the literature disclosed but 3 similar cases, one by Wagenmann,[31] who also was fortunate enough, on a single occasion, to observe the cycle of oncoming spasm, occlusion and relaxation of spasm. The second was by Benson,[32] who examined ophthalmoscopically a case during the existence of total blindness and during attacks of partial blindness. The third was that of Sachs,[33] who observed spasm of a branch of the central artery of the retina. Wagenmann's case briefly is as follows:

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[31] Graefe's Arch., vol. xliv.

[32] Report Internat. Ophth. Cong., 1904.

[33] Beiträg. z. Augenheilk., vol. xliv.

A man, aged 69 years, had for two months noticed frequent, and of late, almost daily attacks of blindness in the right eye, lasting from a few minutes to a few hours. He had had epileptiform attacks in childhood, but was now healthy except for arteriosclerosis.

The changes observed were, "in a short time perception of light was gone, and with it direct and consensual pupil reaction. Externally no change. Ophthalmoscopically, disc pale, arteries appeared as shiny streaks in which no blood columns could be seen, even with the direct method. Veins thread like. No pulsation on pressure. Soon the retina became cloudy and the fovea stood out as a round red spot. About ten minutes after the beginning of the attack a fine red line was seen by the indirect image to appear in the arteries, and immediately afterwards the veins became large. Thereupon the patient had perception of light, and the pupil reacted a little. In a few minutes the circulation, and with it the vision, was completely restored."[34]

Following is an abstract of the case of Benson:

For more than four years a man, aged 32, in good health, had had numerous attacks of transient blindness, sometimes complete, at other times involving only a section of the field. During an attack of complete blindness the ophthalmoscopic examination revealed the inferior temporal artery entirely bloodless for a distance of four disc's diameter from its point of emergence. The bloodless section was seen to shift toward the periphery until it reached the next large bifurcation, when it suddenly disappeared, leaving the blood vessels normal. The same phenomena were noticed during attacks of partial blindness.

Sach's case resembled that of Benson:

In the affected eye a circular constriction would start from the papillary end of the inferior artery and travel to the point of first bifurcation, taking from three to five minutes to make the journey, a distance of one-half the disc's diameter. The fundus was typical of that embolism. When again seen three days later only the picture of embolism was present. The patient had arteriosclerosis.

The value of every such clinical observation will be appreciated on considering the uncertainty which exists as to the most common lesion leading to the fundus picture of obstruction of the central artery of the retina, an uncertainty which persists, notwithstanding the fact that almost a score of eyes thus affected have been examined anatomically. The reason for this being due,

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34. Ophth. Rev., 1902.

in part, to the long period of time which usually elapsed between the time of the occurrence of obstruction and the necessity for enucleation from secondary causes.

Thompson[34] has so recently brought together for critical consideration the arguments for and against the various conditions assigned as the cause that it is unnecessary at the present time to reconsider them. Suffice it to note that neither Reimar[35] nor Haab[36] is satisfied that any one of the anatomic studies has proven the existence of embolism and that Schweigger[37] has stated his belief that endarteritis is the usual cause and that early clouding of the retina with a cherry red spot would not be an early occurrence in embolism. Haab, in his able critical consideration of the subject, states that evidence of the occurrence of spasm of the central artery of the retina would render great service in explaining the prodromal periodic blindings and especially the filling of the retinal vessels that is seen immediately after the blinding. According to Haab the sequence of events, as the result of disease of the vessel walls would be: narrowing of the lumen of the vessels, but insufficient to interrupt the retinal function, followed by spasm of the vessel walls causing temporary blindness and, if a thrombus formed, permanent blindness. Kern[38] states that in 66 per cent. of cases of so-called embolism no assured source of embolus was present. He concludes that the cause is usually a local disease, such as atheroma, of the central artery.

Wagenmann says that where the intima is thickened the spasmodic contraction would be all the more likely to produce ischemia. He considers spasm of the coronary arteries with functional disturbance of the heart which occurs in arteriosclerosis of these vessels, an analogous condition.

An interesting feature in some of these cases has been the long period of time over which the blindness extended with ultimate restoration of vision. In von Graefe's and in Rothmund's cases several days intervened between the onset and recovery, and in the case of Noyes, where repeated previous attacks of transient blindness authenticated the cause as a vascular one, blindness persisted 16 hours with recovery, and recently Barrett recorded an instance where the attack lasted two hours with a return to normal vision. It would seem that in these cases sufficient circulation remains to sustain the anatomic integrity, but not the functional activity of the retina.

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[35] Arch. f. Augenheilk., vol. xxxviii.

[36] Norris and Oliver. System of Diseases of the Eye.

[37] Knapp's Arch. of Ophth., 1901.

[38] Inaug., Dissert. (Refer to Wagenmann, footnote 31.)

*Prognosis.*—In considering the prognosis of transient blindness a distinction should be made between those cases where the attack is but a symptom of a general condition in which spasm is a feature, as epilepsy, Raynaud's disease, migraine and the ague of intermittent fever, in which the prognosis is good, and where it is due probably to a local manifestation of a general vascular disturbance in which the prognosis is grave. In the latter class the danger lies mainly in the secondary effect of the spasm, for, excluding the cases in which a reasonable doubt may exist as to the cause of the ischemia, there yet remain several cases in which, although the blindness lasted for many hours, a full recovery of retinal function followed.

*Treatment.*—The indications to be met are those of early arteriosclerosis, high arterial tension and spasm. The only drug that has secured any standing in combating this insidious affection is the iodid of potassium. It is to be given in doses of from 3 to 5 gr. three times a day in large draughts of water after meals so soon as there is any indication of capillary fibrosis, and is to be continued in interrupted courses thereafter. It should be needless to add that moderation in eating, drinking, exercise, pursuit of business and pleasure is more essential than regularity in taking medicine.

The nitrites are potent in reducing arterial tension. Nitroglycerin commends itself because of its convenience in administration. Nitrite of amyl, by reason of its quick action, is especially indicated for the attack, but frequently appears to have but little effect in modifying it. Heart tonics are usually called for to improve the circulation. The value of massage of the eyeball has been demonstrated in the treatment of cases exhibiting the symptoms of obstruction and should always be tried.

The question of the advisability of performing an iridectomy must be decided for each individual case. We have seen that recovery has followed alteration of circulation brought about by performing paracentesis of the anterior chamber and that iridectomy has failed in the one case of undoubted spasm in which it was done. The performance of an operation whose action is problematic for the relief of a condition which, if not problematic, is perhaps only the local expression of a general condition will not appeal to every one. It would seem that the operation might be justified where the obstruction had resisted the usual means employed for relief until permanent injury to vision was likely to result. But that it would guard against subsequent attacks is scarcely to be expected.

1819 Spruce Street.

CHICAGO:
PRESS OF THE AMERICAN MEDICAL ASSOCIATION,
ONE HUNDRED AND THREE DEARBORN AVENUE,
1906.

# THE RELATION OF DISEASE OF THE NASAL ACCESSORY SINUSES TO DISEASE OF THE EYES.*

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CHICAGO.

That the nose and its pathology have a direct influence on the health and function of the eyes has long been admitted, and the more obvious and striking forms of interdependent diseases have for a long period been recognized and treated.

It is unnecessary to mention the ordinary examples of associated disease. I wish to call your attention to a practically unrecognized condition. The symptoms of this condition are purely ocular. The patient never has a reason to suspect a nasal origin, and, as use of the eyes almost invariably increases the headache of this condition, he consults an oculist for relief. Another reason for believing that the eyes are at fault is that correct glasses relieve for a time all or the greater part of the symptoms. This may be explained by the lessened congestion of the ciliary body resulting from a relief of eyestrain, however small in amount. And, as congestion is the basis of this condition, even a slight reduction of its total amount will, for a time, give relief from the more prominent eye symptoms.

The first point which attracted my attention to the possibility of involvement of the neighboring sinuses was that this particular class of headaches was usually unilateral, or, if bilateral, the pain was greater about one or the other eye. The nose, however, shows no distinct anatomic or pathologic condition to account for the one-sided headache, except on very close examination with suprarenalin and cocain, when the middle turbinal will be seen to be closely applied in its anterior third to the lateral nasal wall, or even may be found sufficiently boggy or hypertrophied to resist shrinkage by these agents. The literature, especially the German, furnishes abundant evidence of the close relation existing between these sinuses and the orbital contents. These cases, however, are all of the suppurative type of sinuitis, and a nasal examination reveals evidence of pus in one or more of the locations characteristic of sinus infection, while in the class of cases here presented no pus could be detected in the nose at any time except in a few cases which showed mucopus after probing and irrigating the frontal sinus.

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* This paper has been accepted by the executive committee of the Section on Ophthalmology of the American Medical Association, to be presented before the Section at the Boston Session, June 5-8, 1906, and to be published in THE JOURNAL A. M. A. later.

The frontal sinus and the ethmoid cells opening into the infundibulum are the sinuses chiefly involved. Pihl[1] reports a case of retrobulbar neuritis from chronic antrum suppuration, but here again the presence of pus coming from the antrum should be easily demonstrated, and it is almost impossible for the nonsuppurative condition here described to occur in the antrum of Highmore, because, from its position at the lower end of the hiatus semilunaris, the ostium is never blocked by a congested middle turbinal or, at least, if blocked at all, it is frequently reopened by the varying turgescence of the turbinal.

The clinical picture presented in this condition is as follows: The origin of the trouble dates back to an attack of so-called grippe or to a very severe cold. The patient has had headaches more or less severe and always unilateral when they first appear, although often they become general after an hour or more. The patient usually speaks of having neuralgia. The pain occurs during sleep as well as in the daytime, frequently beginning and ending with some regularity at a given hour each day. During the existence of the pain there is often unilateral lacrimation, swelling of the upper eyelid and tenderness on pressure at the inner orbital angle or over the anterior wall and floor of the frontal sinus as compared with pressure applied to the same areas on the opposite side. The patient experiences intervals of complete relief, during which the eyes may be used for near work indefinitely. During attacks, however, use of the eyes is almost impossible, as it intensifies the symptoms markedly and may even be accompanied by

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1. Pihl: Klin. Monats, f. Augenh., July, 1903.

blurring and mixing of print. Insufficiency of both accommodation and convergence is usually observed and there may be a reduction of distant vision.

On stooping over to pick up an article from the floor the patient experiences marked increase in pain and often becomes dizzy on resuming the erect position. While stooping he is usually able to put his finger on the area of greatest pain and describes the sensation as one of increasing pressure as though the painful area was being pushed slowly forward by a force from behind. The circulatory disturbances of the menstrual period aggravate the condition and each cold brings it on. Jarring, as in riding on a train, is almost unbearable during an attack. The patient's ability to think clearly is disturbed. The pain is only partially controllable by opiates. Excess in eating or drinking alcoholic beverages aggravates or even may bring on attacks.

As a rule, no history of nasal disease is obtainable. In fact, patients often object to a nasal examination as a waste of time and a useless procedure, being perfectly sure that the trouble is entirely in the eyes. Close examination will reveal a swollen boggy turbinal or one which is anatomically so closely applied to the lateral nasal wall as to press on the hiatus semilunaris and thus interfere with the free interchange of air and the free exit of normal secretions from the frontal and anterior ethmoidal cells.

If a patient gives a history of having experienced any of the above symptoms he should be seen during an attack and an attempt made to relieve the acute symptoms with suprarenalin and cocain applied about the middle turbinal and into the infundibulum where possible. If an attack can be relieved in this manner a resection of the hypertrophied anterior end of the middle turbinal is indicated in order to give free access to the infundibulum and hiatus semilunaris.

The etiology of this condition depends on the anatomic relation of the middle turbinal to the hiatus semilunaris and the infundibulum. The air in the frontal and anterior ethmoidal cells is imprisoned there by pressure of the middle turbinal against the lateral nasal wall, the turgescent tissues filling in the hiatus semilunaris and effectually blocking it. The lining mucous membrane of the sinuses absorbs the oxygen in the imprisoned air and thus creates a vacuum. This absorption results in negative pressure and consequent swelling of the lining membrane with increased blood supply to this region. Stasis, to a greater or less degree, results and may be shown by swelling of the upper eyelid. Pressure of the congested tissues on the contained nerve endings, together with this stasis, produces the symptoms and results in reflex vasomotor disturbances in the circulation of the neighboring structures. Robertson[2] advances a similar theory. Ewing and Sluder[3] described a similar condition which Sluder ascribed to an abnormal approximation of the uncinate process of the ethmoid to the bulla of the ethmoid.

I have also seen the specimen in Hajek's collection, to which Sluder refers, and it is easy to understand how such a narrowing of the hiatus might cause this condition by turgescence of its own lining membrane. This must be rare, however, as compared with a pathologic turbinal which possesses infinitely greater possibilities for alternate shrinking and swelling owing to its venous sinuses. Sluder and Ewing offer no explanation of the condition, being satisfied with the statement that there is an intrasinus change of air pressure. The long-recognized otalgia in acute otitis media is analogous in its etiology to this sinus condition. It seems improbable that sufficient stasis could occur throughout the orbital circulation to bring about such severe symptoms by itself alone. The exit of blood from the orbital structures is well provided for by the superior and inferior ophthalmic veins and their communicating branches emptying backward into the cavernous sinus and the ophthalmo-facial vein emptying forward into the facial vein. The ophthalmo-facial vein anastomoses with the above ophthalmic veins, and in case of need the main venous current may flow into the deep veins of the face instead of, as usual, into the cavernous sinus.

This suggests the probability of a further influence which, I think, is to be found in the disturbances of vasomotor control secondary to the irritation of the branches of the fifth nerve lying in the lining membrane of these sinuses. That no direct circulation of infectious material occurs in the orbital vessels is shown by the subsidence of all symptoms in a few minutes in typical cases when patulency of the infundibulum is restored. On the other hand, the arterial supply to these sinuses comes from the ophthalmic artery and the stasis within the sinuses must cause back pressure in the orbital branches of this artery.

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[2] Robertson: THE JOURNAL A. M. A., March 5, 1904.

[3] Ewing and Sluder: Trans. Amer. Oph. Society, May 2, 1900.

Pus or mucopus may or may not be found and when present indicates only that the mucous transuded from the swollen membrane has become infected from the nose. In fact, it is not impossible to imagine that a great many cases of suppurative sinuitis have their origin in a frequently recurring condition such as is here described. The essence of the whole matter is that there is interference with the free interchange of air between the nasal chamber and the accessory sinuses.

In going over the literature of sinus disease I found nothing in reference to the particular type of disease here described. Ziem[4] found disease of the uveal tract to be a frequent result of chronic nasal disease either directly from an accessory sinus by way of the veins and lymphatics or indirectly through the general circulation. Recurring cyclitis and choroiditis and even glaucoma in the early stages are favorably influenced by treatment of the accessory sinus infection. Senile cataract he found to be always accompanied by chronic pus discharge from the nose, and in those cases where the cataract was not mature he obtained increased vision by treatment of the nasal condition, although the lens opacity was unaffected. In empyema of the antrum of Highmore, Ziem[4] frequently found contraction of the visual field. This observation has been confirmed by Berger and by Kuhnt, not only in involvement of the maxillary sinus, but also of the frontal and other accessory sinuses. The fields showed no typical picture, as in one case the field for white would be contracted and that for colors only slightly affected and *vice versa.* In a few cases, in addition to the concentric contraction, a further segment-like contraction was observed in that portion of the field corresponding to the location of the sinus involved.

Grünwald, Engelmann and M. Schmidt found no contraction of the visual fields.

Kuhnt saw several cases in which one or both nostrils were completely closed so that not even by the greatest effort could air pass through them, and there existed no trace of lowered vision, contracted fields, muscular or accommodative asthenopia.

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[4] Ziem: Centralbl. f. Augenh., 1887, pp. 131, 358; also Monats. f. Ohrenh., pp. 231, 261, 371, 150; Berlin. klin. Wochft., Nos. 37, 38, 39; Internat. klin. Runschau, p. 324; Deutsche med. Wochft., No. 5; Munch. med. Wochft., No. 16.

Ziem[4] considers that the functional disturbances of the eyes are due to a passive congestion of the orbit and of the choroid and ciliary body.

Hajek has observed asthenopic symptoms in cases in which the ethmoid cells were involved, as well as in many cases of frontal and maxillary sinus involvement. Grünwald believes that all tissues in the neighborhood of the infected sinus are in an inflammatory condition which is exaggerated by any strain or effort which increases the blood flow to the part, such as an accommodative effort which brings on a sensation of discomfort. This discomfort is relieved by an unconscious relaxation of the accommodation, and the patient experiences a blurring and haziness of the object looked at. This Grünwald terms psychic asthenopia.

Berger, Knies and Zarniko[5] believe the ocular symptoms to be reflex in nature from the sensory nerve ending of the nasal mucosa.

Zarniko[5] holds that to make Ziem's theory of passive congestion tenable the venous channels of the orbit must be relatively small and narrow. I am inclined to agree with Zarniko in this particular, as the reverse is true, the exit of venous blood from the orbit being particularly well provided for in all directions, both backward in the cavernous sinus through the superior and inferior ophthalmic veins and into the deep veins of the face through the ophthalmo-facial which connects with the inferior ophthalmic vein. The main vein, the superior ophthalmic, has no valves except where tributary veins enter, and so its blood may flow in either direction, into the cavernous sinus or through the communicating vein into the inferior ophthalmic and so into the deep veins of the face.

Eversbusch has observed that in sympathetic ophthalmia there is often marked swelling in the nose on the side first affected and that it remains unilateral until the later stages of the process. He now considers this to be an important symptom preceding the prodromal symptoms of involvement of the healthy eye, and has the nose examined in each case where sympathetic ophthalmia might be expected, in order not to wait too long before enucleating; and also in enucleating the first eye he does not suture the conjunctiva nor use a pressure bandage, as he considers a free flow of blood necessary to remove the toxins which remain in the veins of the orbit and nose.

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[5] Zarniko: Die Krankheiten der Nase und des Nasenrachens, Berlin.

In the exacerbation of iridocyclitis, Eversbusch has many times found an accompanying catarrhal nasal condition or a marked exacerbation of an existing catarrh. In a case of severe iridocyclitis, when the patient refused enucleation and all treatment for two months had failed to influence the condition, Eversbusch had a hypertrophied inferior turbinal removed as a last resort. There was free bleeding for several hours, with the result that the ciliary injection disappeared almost entirely in both eyes, the vitreous haze cleared and the action of the mydriatics, previously unsatisfactory, became complete. This improvement lasted eight or ten days, when a fresh attack both in nose and eyes was relieved by enucleation of the first eye, the second eye healing with full vision.

The treatment of this condition is operative. Having made the diagnosis, the middle turbinal should be cocainized and a notch made at the point of its anterior insertion into the lateral nasal wall, a Myles punch being used. The free end of a wire loop on a Krause snare is now introduced into the notch, where it is held firmly while the canula of the snare is pushed along the under surface of the middle turbinal as far as is considered necessary. Closing the snare gives a clean-cut, smooth-edged wound which rapidly heals. In case the turbinal is not large, much useful tissue may be saved by merely punching out a portion along its line of insertion, thus uncovering the hiatus. As a rule, probing and irrigation are unnecessary and when carried out always leave room for doubt as to the part they play in producing the mucopus occasionally found.

## HISTORY OF CASES.

Case 1.—Mrs. E. had pain in left eye in 1892 after "grippe," beginning after rising and continuing until 10 a. m., when it gradually became easier and ceased entirely at noon. The condition improved during the summer, but each winter during the months of January, February and March she has had similar attacks of variable severity.

In February, 1905, she caught cold and pain appeared about left eye, beginning at 9 a. m. and ending at 2 p. m., leaving the eye weak and watery, especially when she tried to read. The ocular condition was normal, but there was tenderness on percussion and pressure about left frontal sinus. No pus was found in nose, but a large septal spur, which pressed against the middle turbinal and kept it constantly irritated and congested, was removed and astringent applications were made to the turbinal. One hour later the pain had disappeared. For three weeks there was a mucopus discharge, slight in amount, seen under the middle turbinal, but the restored drainage banished all symptoms.

Case 2.—Mrs. C. H. H. six years ago noticed tiring of eyes after an hour's reading. Two or three times weekly she has supraorbital pain, chiefly about right eye. After correction of a compound hypermetropic astigmatism and prism exercises for an exophoria, she ran an unsatisfactory course for a year until last March, when she had a distinct severe neuralgia of right eye and subconjunctival hemorrhage, with soreness of globe and lacrimation. There was no marked tenderness about the frontal sinus, but she had a watery nasal discharge. No pus was found at any time. The middle and inferior turbinate bodies were very boggy and were reduced with difficulty. Thorough shrinking, however, was sufficient to bring relief at once. Local astringent applications entirely cured the condition without any attempt at probing the frontal sinus. Later she was without her glasses for four or five days without a symptom.

Case 3.—Mrs. S. gives a history of unilateral neuralgic pain in left eye and back of head for past three or four years; it has been worse lately and now is accompanied by lacrimation and some edema of lids of left eye. She thinks she has noticed occasional yellow discharge from nose; on pressure there is tenderness over anterior wall of left frontal sinus and against its floor. No pus was found in nose, but the turbinals were boggy. Patient could read only twenty minutes when lacrimation would begin, worse in left eye. The sinus was probed and irrigated and a small amount of thick pus found, which probably accounted for a bad odor, of which she had occasionally complained. The sinus was irrigated several times and the patient experienced immediate relief. There was some mucopus flow for about one month, according to the patient, but no return of the symptoms.

Case 4.—W. A. W. four or five years ago had neuralgic pains about left eye. Four weeks ago he had grippe, with excessive nasal discharge. One week later supraorbital pains began about left eye. Pain begins at 2 a. m., and patient has three separate attacks, usually at 2, 5 and 7 a. m. Boggy turbinates on left side were found, but no pus at any time nor local tenderness about sinus. He was given a suprarenalin spray for home use and local astringents were used twice in office with complete relief at once. There has been no recurrence to date. He had been wearing + 0.25 cyl., ax. 90, each eye, which, as it had given no relief, he has discarded.

Case 5.—M. W. B. gave a history of catarrh for four years, accompanied by frontal headache, worse about right eye. With each eye under homatropin, refraction was $+0.50$ S. $\overset{\frown}{\smile}$ $+0.25$ cyl., ax. 90. No glasses were ordered. Marked tearing and blurred vision occurred after a few minutes' near work. There was some tenderness to pressure about the sinus floor on right side, and the right middle and inferior turbinals were swollen and boggy. No pus was found and shrinking of the middle turbinal gave no relief. Next day the anterior third of this turbinal was resected and the sinus probed. Free flow of pus was followed with complete relief of pain in half an hour. Irrigation of the sinus was attempted with doubtful results. There was a mucopurulent discharge, gradually getting thinner and less in amount for six weeks, since which time there has been none whatever. He had been having his eyes examined occasionally for eight years, with absolutely no relief, but still thought the eyes were at fault and came to me to have them examined again. He now uses them excessively, as he is a senior medical student. There has been no return of symptoms to date.

CASE 6.—Mrs. L. formerly had typical migrain, but attacks have been infrequent for the past three or four years. Two years ago noticed pain in both globes at night and especially in church or theater. Atropin continued for two or three weeks seemed to relieve her. While in the West she had a severe attack of pain about the left eye. The eye became bloodshot, tears streamed from it and reading was impossible, as it increased the pain. Close questioning developed the fact that there was a nasal discharge at the time. Later she had a similar attack in the same eye and obtained no relief from atropin. At this time she remembers that there was a nasal discharge. She has consulted many ophthalmologists of repute, who changed her glasses, exercised her muscles, etc., without permanent relief. Recently she had two attacks like the above, except that she has not observed any nasal discharge whatever. Atropin was useless. Some tenderness of left sinus floor was found during an acute attack last May. She had been instructed to come in at once if an attack occurred, and she came within half an hour of the onset, with the eyelids red and swollen and tears streaming over her cheek. Suprarenalin applied to region of middle turbinal entirely relieved the pain in ten minutes. The anterior third of left middle turbinate was resected without probing sinus, and she has had no recurrence except once, recently, when she had a slight return of the pain, which was permanently relieved by application of 1 per cent. iodin in glycerin to the region of the hiatus. Has discarded her glasses.

CASE 7.—Mrs. E. J. M. five years ago had a severe attack of "grippe," and for several months had photophobia and frontotemporal headaches daily and could not use eyes for near. For past three months pain in frontal and temporal region has been almost constant and caused insomnia and extreme nervousness. Three weeks ago vision began to fail and headaches continued.

with soreness in the bony margin of the orbit. Right eye first began to fail, followed by same condition in the left eye. Stooping increases pain and causes vertigo. A cold marked the beginning of present attack, accompanied by occasional thick nasal discharge, greenish in color. Pain persists, but discharge is watery now. Middle turbinals on both sides were hypertrophied and on the left boggy and edematous. No pus was found. After shrinking the left middle turbinal a thin, colorless mucus was seen in the middle meatus. There was extreme tenderness about both frontal sinuses on pressure and percussion. L. V. 20/40 and J. 1; R. V. 20/30 and J. 1. Refraction under homatropin in each eye was + 1.00 S. $\overset{\frown}{\smile}$ + 0.25 cyl., ax. 180, which was not ordered.

Maddox rod..........crossed diplopia, one degree
Parallax test ........................exophoria
Red glass....crossed diplopia with instant fusion

For near there were five degrees of exophoria, as shown by the tangent scale. Resection of the anterior third of her left middle turbinal and probing of her left frontal sinus relieved the condition in one hour's time and has had no headaches since. The right side was similarly treated, as tenderness persisted about the frontal sinus. No pus was found on the right side, but on irrigation portions of a mucous cast were washed out. A large clot of thick yellow pus was washed from the left frontal sinus on the day following the nasal operation. Vision improved by a few letters daily until the fourth day it was 20/15 in each eye. Nose was still discharging one week later, but there was no return of symptoms, and five months later she reported no return.

CASE 8.—H. A. W. two years ago began to have pain in eyes, especially the right eye. Pain is worse since he has worked indoors by artificial light. Pain begins on rising each morning and continues until noon, with inability to use eyes. In afternoon he uses his eyes indefinitely without symptoms. Has history of nasal catarrh. Right nostril was stuffy from swollen, boggy turbinals. Shrinking turbinals showed mucopus in middle meatus and dropping into throat from right choana. The anterior one-third of his right middle turbinate was resected and mucopus flowed from frontal sinus, with complete relief of all pain and ocular symptoms. His refraction was an irregular compound hypermetropic astigmatism of low degree, and glasses were not prescribed, as the nasal treatment gave complete relief. This case is one of the few in which discharge was actually found, and then only on careful shrinking and probing in the middle meatus.

CASE 9.—H. T., aged 13 years, had headache and pain in eyes, with blurring of print. Her general health was good, except for several indefinite rheumatic attacks. Dr. Frank Allport prescribed + 0.25 S. $\overset{\frown}{\smile}$ 0.25 cyl., ax. 180 for both eyes for reading. These glasses gave her so much relief that she wore them constantly. For three months patient did well, but began again to have pain in and over eyes. The pain about left eye

**was then, for the first time, worse than the right. This suggested a nasal examination, and the turbinates of the left nostril were found to be swollen somewhat and to be interfering with breathing. The fact was then brought out that with colds she usually had such headache, which was increased markedly by stooping over and was followed by dizziness. The frontal floors were tender. There was some purulent nasal discharge of slight amount, indicating the last stages of her acute rhinitis, but examination of the sinuses failed to show any discharge. Local astringent treatment cleared the nasal condition and the headache and she now requires glasses only for reading.**

**Case 10.—Dr. M. never had headaches until a year ago, although he has worn glasses for twelve years for a mixed astigmatism. A year ago he began to have occasional neuralgia of the left supraorbital region, usually coming on about 12 o'clock. About three months ago he had a very severe attack, which had lasted with varying severity for a week. His nose showed atrophic rhinitis, but there remained sufficient of the middle turbinate on the left side to obstruct the infundibulum.**

**His pain was markedly increased on stooping, and this fact first drew my attention to his condition, as, during a call on him at his home, I noticed that in hunting for an article in a closet he did not dare bend over on account of the severe pain it caused him, and was obliged to call a servant to help him. A portion of the left middle turbinate at its anterior insertion was punched away and a probe passed into the frontal sinus, resulting in complete cessation of the headache, with no return to date.**

In Case 6 of a series reported, Dr. Kate Baldwin[6] attributes the relief from headache and inability to use eyes during attacks to relief of intranasal pressure, following a middle turbinectomy, while the case is to me obviously one of obstruction to the outlets of the frontal and ethmoidal sinuses. The typical symptoms she gives as follows: Marked exophoria, pain since 18 years of age in left temple, eye and teeth, with fullness in left side of nose occurring about 10 a. m., passing away in one or two hours with or without treatment; relief was always accompanied by a small quantity of clear fluid mucus from nose, whereas during the attack the nose had been very dry. The middle turbinate was so swollen and boggy that cocain was of no avail and chloroform was employed. No reflex neuroses, such as sneezing, cough, etc., were present as should be expected if the case were one of pure pressure against the septum, while the history, taken with the others related in this paper, seems to me to leave no room for doubt as to the real condition.

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[6] Laryngoscope, Oct., 1905.

Also in Case 7 the significant symptoms correspond with those given in my cases. The patient showed marked exophoria with diplopia at times, pain over left eye and in left temple, swelling of upper lid and pain in eyeball, indistinct vision, improvement of vision and exophoria after middle turbinectomy. No doubt the other typical symptoms could have been found if the sinuses had been suspected.

In none of my cases have I been able to find any fundus changes as Posey[7] has observed several times. I have never seen a case of iritis or uveitis which I could prove to be caused by the accessory sinuses as reported by Fish,[8] but I am constantly on the alert for such cases and have made the examination of the nose and sinuses part of the routine examination of the eyes.

The point which I wish especially to emphasize is the absence of all definite nasal symptoms and the apparently normal nose found. All symptoms point to the eyes, and the patient often objects to having his nose examined, as he is so very sure that he has no nasal trouble. These cases exist in all degrees of severity, from occasional eyeache or browache to acute suppuration in the sinus. It is the more frequent but less obvious nonsuppurative cases that we are overlooking and treating for muscular anomalies. I have relieved the milder unilateral pain at least twenty times in my own case by applying suprarenalin to the middle turbinal of the affected side.

My thanks are due to Dr. Casey Wood, Dr. Frank Allport and Dr. Thomas Woodruff for their courtesy in referring their cases to me for examination and for their assistance in the study of this condition.

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[7] Posey: Jour. Eye, Ear, Nose and Throat Diseases, March-April, 1905; The Journal A. M. A., Sept. 9, 1905.

[8] Fish: Amer. Journal Oph., December, 1904.

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